INSTREAM FLOW EVALUATION FOR SELECTED STREAMS IN THE KOOTENAI NATIONAL FOREST OF MONTANA

by

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INTRODUCTION

The purpose of this report is to provide the Kootenai National Forest with instream flow related information for 12 trout streams in northwest Montana. These streams are generally of mutual interest to both the Montana Department of Fish, Wildlife and Parks (MDFWP) and the Kootenai National Forest due to their high fishery, recreational and other resource values.

Two types of basic instream flow information are provided. They consist of fish population data and a quantification, in terms of cubic feet per second, of the instream flows needed for maintaining the existing fishery resource. Other pertinent background and descriptive information for the streams of interest is also provided.

The 12 contract streams are listed in alphabetical order below:

Bobtail Creek
East Fork Bull River
Fortine Creek
Libby Creek
O'Brien Creek
Pinkham Creek
Pipe Creek
Rock Creek
Ross Creek
Tobacco River
Yaak River
Young Creek

The methodologies used in quantifying the instream flow needs, fish sampling techniques and other related information are thoroughly discussed in the following sections.

INSTREAM FLOW METHODOLOGIES

The best and most accurate method for determining the instream flow needs for fish and wildlife purposes is to derive the actual flow and biological relationships from long-term data collected in drought, normal and above normal water years. While this approach has been tried on a few selected waterways in Montana, it is not a practical means of deriving future recommendations due to the excessive time, cost and manpower required to collect field data. Consequently, flow recommendations for most waterways are derived from instream flow methods that are more compatible with existing budget and time constraints, yet provide acceptable and defendable recommendations.

The method of the MDFWP divides the annual flow cycle for the headwater streams and rivers into two separate periods. They consist of a relatively brief snow runoff or high flow period, when a large percentage of the annual water yield is passed through the system, and a nonrunoff or low flow period which is characterized by relatively stable base flows maintained primarily by groundwater outflow. For headwater rivers and streams, the high flow period generally includes the months of May, June and July while the remaining months (approximately August through April) encompass the low flow period.

Separate instream flow methodologies are applied to each period. Further, it is necessary to classify a waterway as a stream or river and to use a somewhat different approach when deriving low flow recommendations for each. A waterway is considered a stream if the mean annual flow is less than approximately 200 cfs. The vast majority of waterways discussed in later sections have mean annual flows less than 100 cfs.

Methodology for Low Flow Period - Streams

The methodology chosen for deriving low flow recommendations for headwater trout streams is primarily based on the assumption that the food supply is a major factor influencing a stream's carrying capacity (the numbers and pounds of trout that can be maintained indefinitely by the aquatic habitat). The principal food of both the juvenile and adult trout inhabiting the headwater streams of Montana is aquatic invertebrates which are primarily produced in the riffle areas of most streams. The methodology assumes that the trout carrying capacity is proportional to food production which in turn is proportional to the wetted perimeter in riffle areas. This method is a slightly modified version of the Washington Method (Collings, 1972 and 1974) which is based on the premise that the rearing of juvenile salmon is proportional to food production which in turn is proportional to the wetted perimeter in riffle areas. The Idaho Method (White and Cochnauer, 1975 and White, 1976) is also based on a similar premise.

Wetted perimeter is the distance along the bottom and sides of a channel cross-section in contact with water (Figure 1). As the flow in the stream channel decreases, the wetted perimeter also decreases, but the rate of loss of wetted perimeter is not constant throughout the entire range of flows. An example of a relationship between wetted perimeter and flow for a riffle cross-section is illustrated in Figure 2 .

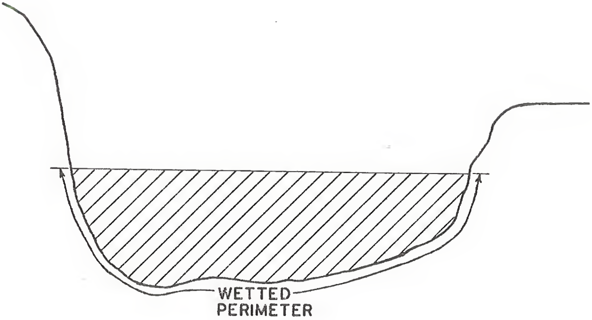

Figure 1. The wetted perimeter in a channel cross-section.

There are generally two points, called inflection points, on the plot of wetted perimeter versus flow at which the rate of loss of wetted perimeter is significantly changed. In the example (Figure 2), these inflection points occur at approximate flows of 8 and 12 cfs. Beyond the upper inflection point, large changes in flow cause only very small changes in wetted perimeter. The area available for food production is considered near optimal beyond this inflection point. Below the upper inflection point, the stream begins to pull away from the riffle bottom. At the lower inflection point, the rate of loss of wetted perimeter begins to rapidly accelerate. Once flows are reduced below the lower inflection point, the riffle bottom is being exposed at an accelerated rate and the area available for food production greatly diminishes.

The wetted perimeter-flow relationship may also provide an index of other limiting factors that influence a stream's carrying capacity. One such factor is cover. Cover, or shelter, has long been recognized as one of the basic and essential components of fish habitat. Cover serves as a means for avoiding predators and provides areas of moderate current speed used as resting and holding areas by fish. It is fairly well documented that cover improvements will normally increase the carrying capacity of streams, especially for larger size fish. Cover can be significantly influenced by streamflow.

In the headwater streams of Montana, overhanging and submerged bank vegetation is an important component of trout cover. The wetted perimeter-flow relationship for a stream channel may bear some similarity to the relationship between bank cover and flow. At the upper inflection point, the water begins to pull away from the banks, bank cover is lost and the stream's carrying capacity declines. Flows exceeding the upper inflection point are considered to provide near optimal bank cover. At flows below the lower inflection point, the water is sufficiently removed from the bank cover to severely reduce its value as fish shelter. It is reasonable to assume that this premise would be more acceptable if the wetted perimeter-flow relationships were also derived for pools and runs, areas normally inhabited by adult trout. However, cross-sections through pools and runs may not be necessary. When the wetted perimeter-flow relationship for riffles and the composite of all habitat types (pools, runs and riffles) comprising a study section are compared, as illustrated in Figure 3 , the shape of the curves and, consequently, the flows at which the inflection points occur, are very similar. This similarity is probably explained by the fact that most headwater streams, due to their high gradients, tend to be mainly comprised of riffle areas. Pools are generally few in number and poorly developed. A riffle area, therefore, describes the typical habitat type that normally occurs throughout most headwater streams.

It has been demonstrated that riffles are also critical areas for spawning sites of brown trout and shallow inshore areas are required for the rearing of brown and rainbow trout fry (Sando, 1981). It is, therefore, assumed that, in addition to maximizing bank cover and food production, the flows exceeding the upper inflection point would also provide favorable spawning and rearing conditions.

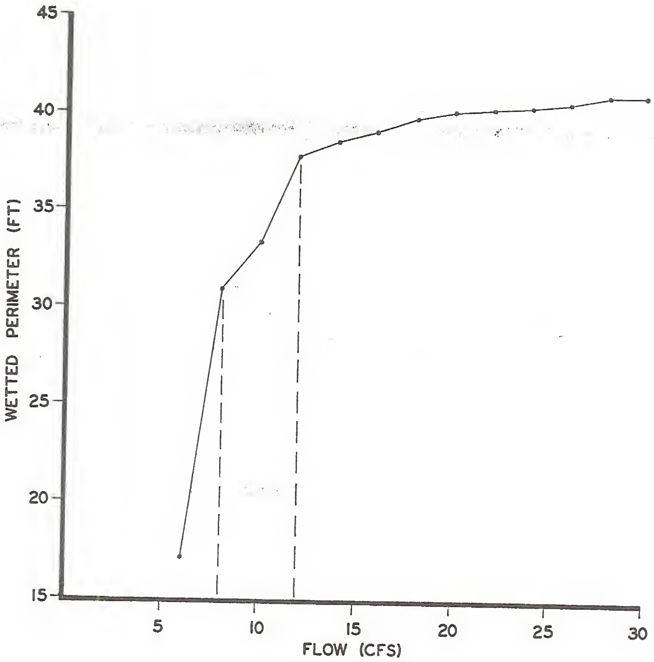

Figure 2. An example of a relationship between wetted perimeter and flow for a riffle cross-section.

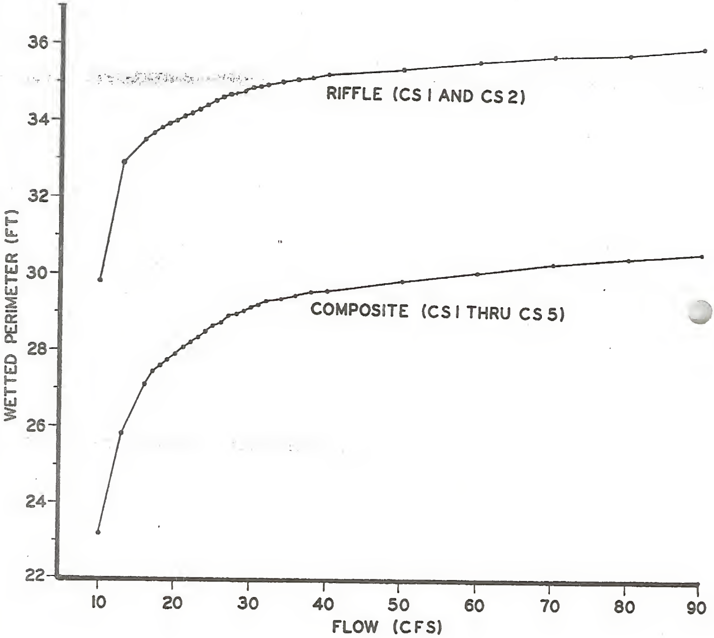

Figure 3. Comparison of the relationships between wetted perimeter and flow for a composite of five cross-sections encompassing various habitat types and a composite of two riffle cross-sections in a subreach of Cherry Creek, Madison River drainage.

Riffles are the area of a stream most affected by flow reductions (Bovee, 1974 and Nelson, 1977). Consequently, the flows that maintain suitable riffle conditions will also maintain suitable conditions in pools and runs, areas normally inhabited by adult trout. Because riffles are the habitat most affected by flow reductions and are essential for the well-being of both resident and migratory trout populations, they should receive the highest priority for instream protection.

The wetted perimeter/inflection point method provides a range of flows (between the lower and upper inflection points) from which a single instream flow recommendation can be selected. Flows below the lower inflection point are judged undesirable based on their probable impacts on food production, bank cover and spawning and rearing habitat, while flows exceeding the upper inflection point are considered to provide a near optimal habitat for trout. The flows at the lower and upper inflection points are believed to bracket those flows needed to maintain the low and high levels of aquatic habitat potential. These flow levels are defined as follows:

1. High Level of Aquatic Habitat Potential - That flow regime which will consistently produce abundant, healthy and thriving aquatic populations. In the case of game fish species, these flows would produce abundant game fish populations capable of sustaining a good to excellent sport fishery for the size of stream involved. For rare, threatened or endangered species, flows to accomplish the high level of aquatic habitat maintenance would: 1) provide the high population levels needed to ensure the continued existence of that species, or 2) provide for flow levels above those which would adversely affect the species.

2. Low Level of Aquatic Habitat Potential - Flows to accomplish a low level of aquatic habitat maintenance would provide for only a low population abundance of the species present. In the case of game fish species, a poor sport fishery could still be provided. For rare, threatened or endangered species, their populations would exist at low or marginal levels. In some cases, this flow level would not be sufficient to maintain certain species.

The final flow recommendation is selected from this range of flows by the fishery biologist who collected, summarized and analyzed all relevant field data for the streams of interest. The biologist's rating of the stream resource forms the basis of the flow selection process. Factors considered in the biologist's evaluation include recreational usage, the existing level of environmental degradation, water availability and the magnitude and composition of existing fish populations. The fish population information, which is essential for all streams, is a major consideration. A nonexistent or poor fishery would likely justify a flow recommendation at or near the lower inflection point unless other considerations, such as the presence of species of special concern (arctic grayling and cutthroat trout), warrant a higher flow. In general, only streams with exceptional resident fish populations or those providing crucial spawning and/or rearing habitat for migratory populations would be considered for a recommendation at or near the upper

inflection point. An exception are those tributary streams that are an essential source of the water that is needed for maintaining downstream aquatic habitat. In this particular situation, water supply is the overriding consideration. Streams in this category include Cabin and Beaver Creeks of the Madison drainage and the West Fork of the Madison River. These and other exceptions are thoroughly discussed in later sections.

The process of deriving the flow recommendation for the low flow period, thusly, combines a field methodology (wetted perimeter/inflection point method) with a thorough evaluation by a field biologist of the existing stream resource.

The wetted perimeter-flow relationships are derived using a wetted perimeter predictive (WETP) computer program developed in 1980 by the Montana Department of Fish, Wildlife and Parks (Nelson, 1980). This program was designed to eliminate the relatively complex data collecting procedures associated with the hydraulic simulation computer models in current use while providing more accurate wetted perimeter predictions.

Description of the WETP Program and Data Collecting Procedures

The WETP program uses at least two sets of stage (water surface elevation) measurements taken at different know discharges (flows) to establish a least-squares fit of log-stage versus log-discharge. Once the stage-discharge rating curve for each cross-section is determined, the stage at a flow of interest can be predicted. This rating curve, when coupled with the cross-sectional profile, is all that is needed to predict the wetted perimeter at most flows of interest.

The program should be run using three sets of stage-discharge data collected at a high, intermediate and low flow. Additional data sets are desirable, but not necessary. The three measurements are made when runoff is receding (high flow), near the end of runoff (intermediate flow) and during late summer-early fall (low flow). The high flow should be considerably less than the bankful flow while the low flow should approximate the lowest flow that normally occurs during the summer-fall field season. Sufficient spread between the highest and lowest calibration flows is needed in order to compute a linear, sloping rating curve (Figure 4).

The WETP program can be run using only two sets of stage-discharge data. This practice is not recommended since substantial "two-point" error can result. However, when only two data sets are obtainable, the higher discharge should be at least twice as high as the lower discharge.

The WETP model is invalidated if channel changes occur in the study area during the data collecting process. For this reason, the collection of the field data needed for calibrating the program should be completed during the period beginning when runoff is receding and ending with the onset of runoff the following year. The stream channel is expected to be stable during this period.

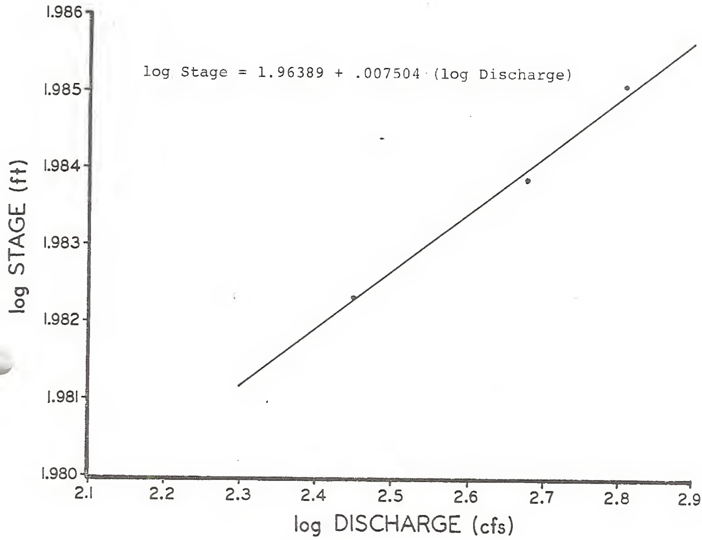

Figure 4. An example of a "three point" stage-discharge rating curve for a riffle cross-section.

Cross-sections were placed in an area that typified the stream reach for which instream flow recommendations were to be derived. For the headwater streams, this would mean a sequence from the head of a riffle to the head of the next riffle. This sequence was described using from 5 to 10 cross-sections. The cross-sections were placed to describe the typical habitat types in the proportion that they occurred within each sequence. The cross-sections were classified as riffles, runs or pools and recorded. The cross-sections through pools and runs were subsequently eliminated from the analyses since, as previously explained, there appears to be little justification or advantage for their use in the flow recommendation process.

The recommendations were selected solely from the wetted perimeter-flow relationships for riffle areas. If two or more riffle cross-sections were available, the computed wetted perimeters for all riffle cross-sections at each flow of interest were averaged and the recommendation selected from the wetted perimeter-flow relationship for the composite of all riffle cross-sections.

The limitations and advantages of the WETP program, as well as field data requirements and surveying techniques, are discussed by Nelson (1980).

Methodology for Low Flow Period - Rivers

The wetted perimeter/inflection point method will, if used correctly, provide defendable flow recommendations for the headwater trout streams. While the underlying assumptions of this method appear valid, it cannot yet be said that the method enables the biologist to accurately predict the effects of flow reductions on the trout standing crops and the carrying capacity of the aquatic habitat. The validation of this method can only be accomplished by comparing the range of possible flow recommendations generated by the method to those recommendations derived from the actual relationships between trout standing crops and flow.

The Montana Department of Fish, Wildlife and Parks completed a study in 1980 that validated the wetted perimeter method as applied to the trout rivers of southwest Montana (Nelson, 1980a, 1980b and 1980c). In this study, the actual trout standing crop and flow relationship were derived from long-term data collected for five reaches of the Madison, Gallatin, Big Hole and Beaverhead Rivers, all nationally acclaimed wild trout fisheries. These relationships provided a range of flow recommendations for each reach. Flows less than the lower limit were judged undesirable since they led to substantial reductions of the standing crops of adult trout or the standing crops of a particular group of adults, such as trophy-size trout. Flows greater than the upper limit supported the highest adult standing crops during the study period. Flows between the lower and upper limits are broadly defined as those flows supporting intermediate standing crops or those standing crops that normally occur within each reach. The final recommendation was selected from this range of flows.

The range of flows derived from the trout-flow relationships for the five river reaches were compared to those derived from the wetted

perimeter method as applied to riffle areas. The study results showed that the inflection point flows had a somewhat different impact on the trout standing crops of rivers than previously assumed for streams. For rivers, the flow at the upper inflection point is a fairly reliable estimate of the lower limit of the range of flows derived from the trout-flow relationships or, in other terms, flows less than the upper inflection point are undesirable as recommendations since they lead to substantial reductions of the standing crops of adult trout.

The flow at the upper inflection point is not necessarily the preferred recommendation for all trout rivers. The "Blue Ribbon" rivers would generally require a higher flow in order to maintain the sport fishery resource at the existing level. For those rivers having a lower resource rating, the flow at the upper inflection point may be a satisfactory recommendation. In general, flows less than the upper inflection point are undesirable as flow recommendations regardless of the existing state of the river resource.

For those rivers that support resident salmonid populations and provide crucial spawning and/or rearing habitat for migratory populations as well, the flow recommendations derived from the wetted perimeter/inflection point method would, in addition to maintaining the resident population at the existing level, also serve to:

1) maintain favorable spawning and incubation habitat,

2) maintain favorable habitat for the rearing of fry and juveniles, and

3) facilitate the movement of juveniles to downstream adult residencies.

Methodologies for High Flow Period - Streams and Rivers

A. Dominant Discharge/Channel Morphology Concept

Several major components of aquatic habitat in river systems are related to the physical features and form of the river channel itself. Over time, aquatic populations have adapted and thrived within the physical contraints of channel configuration and flow. Basic to the maintenance of the existing aquatic populations is the maintenance of the existing habitat that has historically sustained them.

It is generally accepted that the major force in the establishment and maintenance of a particular channel form in view of its bed and bank material is the annual high flow characteristics of the river. It is the high spring flows that determine the shape of the channel rather than the average or low flows.

Most unregulated headwater streams and rivers in Montana are characterized by an annual spring high water period which normally occurs during May, June and July and results from snowmelt in the

mountainous headwaters. Annual spring flow conditions on unregulated streams are heavily dependent upon snowpack and its rate of thawing. On regulated streams, the occurrence and magnitude of the high water period may vary depending upon reservoir operation and storage capacity.

The major functions of the high spring flows in the maintenance of channel form are bedload movement and sediment transport. It is the movement of the bed and bank material and subsequent deposition which forms the mid-channel bars and, subsequently, the islands. High flows are capable of covering already established bars with finer material which leads successively to vegetated islands. Increased discharge associated with spring runoff also results in a flushing action which removes deposited sediments and maintains suitable gravel conditions for aquatic insect production, fish spawning and egg incubation.

Reducing the high spring flows beyond the point where the major amount of bedload and sediment is transported would interrupt the ongoing channel processes and change the existing channel form and bottom substrates. A significantly altered channel configuration would affect both the abundance and species composition of the present aquatic populations by altering the existing habitat types.

Several workers (Leopold, Wolman and Miller 1964, US Bureau of Reclamation 1973, and Emmett 1975) adhere to the concept that the form and configuration of river channels are shaped by and designed to accommodate a dominant discharge. The discharge which is most commonly referred to as a dominant discharge is the bankful discharge (Leopold, Wolman and Miller 1964, Emmett 1975). Bankful discharge is defined as that flow when water just begins to overflow onto the active flood-plain.

Bankful discharge tends to have a constant frequency of occurrence among rivers (Emmett 1975). The recurrence interval for bankful discharge was determined by Emmett (1975) to be 1.5 years and is in close agreement with the frequency of bankful discharge reported by other studies (Leopold, Wolman and Miller 1964, Emmett 1972).

The bankful discharge for streams and rivers was estimated by using the 1½ year frequency peak flow. The 1½ year frequency peak flow was determined by interpolation between the 1.25 and 2 year frequency peak flows as supplied by the USGS for the streams and rivers in question.

It is not presently known how long the bankful flow must be maintained to accomplish the necessary channel formation processes. Until studies further clarify the necessary duration of the bankful discharge, a duration period of 24 hours is chosen.

A gradual rising and receding of flows should be associated with the dominant discharge and the shape of the spring hydrograph should resemble that which occurs naturally. USGS flow records were used to determine the time when the high flow period and peak flow normally occur on a given stream. The dominant discharge is requested for that period when it normally occurs. Flows are increased from a base flow level to the dominant discharge in 2-week intervals at the 80th

percentile flow level, corresponding to the natural timing of the high flow period.

The 80th percentile is the flow that is exceeded in 8 of 10 years or, in other terms, in 8 years out of 10 there is more water than the 80th percentile flowing in the stream. The 80th percentile was chosen in part because of its compatability with irrigation development. To economically develop efficient, full-service irrigation systems, a good water supply is considered necessary in about 8 years out of 10, on the average (MDNRC, 1976). It is also our belief that the high flow months can withstand substantial withdrawals and not alter the basic functions of channel maintenance. The 80th percentile flows allow for substantial water depletions.

The above instream flow method, which is termed the dominant discharge/channel morphology concept, can only be applied to those streams and rivers having at least 9 years of continuous USGS gauge records. While 10 years is the minimum period of record the USGS considers adequate for deriving reliable estimates of the 80th percentile flows, a minimum period of 9 years is used for this report.

High flow recommendations cannot be derived for the vast majority of streams and rivers considered in this report because most lack long-term flow records.

B. Passage of Migrating Trout

The high flow period generally coincides with the period when rainbow and cutthroat trout ascend the tributaries to the Kootenai River and Lake Koocanusa to spawn. Of the twelve streams covered in this report, ten provide important spawning and nursery habitat for migratory salmonids. Consequently, high flow recommendations for many of the streams are based on those flows that are needed to facilitate the upstream passage of adult salmonids to their spawning areas and their return to downstream residencies.

Researchers generally agree that flows are the primary factor controlling trout migrations. Sufficient flows are needed to stimulate spawning movement into the streams and to enable the migrants to successfully traverse shallow riffle areas and other natural barriers while moving to their spawning areas.

Passage criteria developed by the Colorado Division of Wildlife for streams 20 ft and wider indicate that the minimum depth needed to pass trout through riffles is 0.5-0.6 ft (Wesche and Rechard 1980). Passage criteria developed in Oregon are also similar (Thompson 1972). The passage recommendations for this report are derived from the Colorado criteria and the data generated by the WETP program for the riffle cross-sections.

In addition to the wetted perimeter, the WETP program also predicts the average depth for each cross-section at each flow of interest. An example of the information generated for a series of five riffle cross-sections is as follows;

Flow (cfs)	Average Depth (ft) Riffle cs #1	Riffle cs #2	Riffle cs #3	Riffle cs #4	Riffle cs #5
100	.44	.65	.79	.68	.47
110	.49	.69	.85	.72	.52
120	.54	.73	.91	.75	.57

In this example, the average depth for all five riffle cross-sections exceeds 0.5 ft, the approximate minimum depth required for successful passage, at a flow of approximately 120 cfs. A flow of at least 120 cfs is, therefore, needed during the spring spawning period to facilitate the passage of adult trout to upstream spawning areas.

FISH POPULATIONS

Kootenai River Drainage

The salmonid populations within the contract streams, except for Ross Creek, consist of year-round residents and the progeny of migratory game fish which ascend the streams to spawn. Rainbow and cutthroat trout are the most important game fish using these streams for spawning and nursery areas. Resident salmonid populations include rainbow trout, cutthroat trout, brook trout, bull trout and mountain whitefish.

The major cutthroat runs occur in streams tributary to Lake Koocanusa. Westslope cutthroat trout spawners generally begin their spawning runs into the tributaries the first part of May and the run continues into the end of June (May and Huston 1980). Spent spawners begin moving downstream in June and most fish have left the spawning streams by mid-July. The fry emerge from the gravel in August and September. Nearly all juvenile fish live from one to three years in the natal stream before emigrating to Lake Koocanusa. They grow and mature for one to three years in the reservoir before returning to spawn. The majority of cutthroat live two years in the natal stream and two years in the reservoir before maturing and returning to spawn.

Important rainbow trout runs occur in tributary streams to Lake Koocanusa and the Kootenai River downstream from Libby Dam. Rainbow spawning runs usually begin the first part of April and are completed by the end of May (May and Huston 1980). Spent spawners have normally left the tributaries by the end of June. The fry emerge from the gravel from mid-June to mid-August. Most juveniles emigrate from the natal stream in the fall of their first year or the following spring at age one. Most males mature at age two, while the majority of the females spawn for the first time at age three.

The East Fork of the Bull River supports a spawning run of brown trout from Cabinet Gorge Reservoir. Rainbow and cutthroat trout probably use the

East Fork for spawning also, but the magnitude of these runs has not been documented. The brown trout begin ascending the Bull River in mid-October and spawn from the first part of November into the end of December.

FISH POPULATION ESTIMATES

As previously discussed, an evaluation of existing fish populations is an essential component of the flow recommendation process. In addition to providing a means for partially justifying the selection of a particular flow recommendation, the fish data also serve to document the state of the existing fishery resource. Personnel of the MDFWP expended considerable time and effort in collecting this information and summarizing it for use in the recommendation process and for comparison with the populations of other streams and rivers.

Two techniques, electrofishing and snorkeling, were used in surveying fish populations and estimating standing crops. Information about spawning runs was collected by the use of fish traps. These techniques are discussed as follows.

Electrofishing

Fish populations in the streams were sampled using a bank electrofishing unit basically consisting of a 110 volt gas generator, a Cofelt shocker box, a 500 ft cord, and hand-held, mobile negative and positive electrodes. For the larger waterways, a boat mounted electrofishing unit was sometimes required to effectively sample the population. A mild electric shock temporarily immobilizes the fish located in the immediate vicinity of the positive electrode, allowing them to be dip netted. The fish capturing efficiency of the units is highly variable since efficiency rates are influenced by stream size, the magnitude of the flow, water clarity, specific conductance, water temperature, cover types and the species and size of fish.

The fish population is enumerated using a mark-recapture method which allows for the estimation of the total numbers and pounds (the standing crops) of fish within a stream section. For most streams, standing crop estimates were obtained for 1,000 ft study sections. The larger waterways sometimes required longer sections in order to obtain reliable estimates.

The standing crop estimates require at least two electrofishing runs through each study section. During the first or marking run, all captured fish are anesthetized, marked with a partial caudal fin clip so they can be later identified, then released after individual lengths and weights are recorded. It is desirable to make the second or recapture run at least two weeks after the marking run. This two week period allows the marked fish to randomly redistribute themselves throughout the population. During the recapture run, all captured fish are again anesthetized and released after the lengths and weights of all new (unmarked) fish and the length only of all marked fish are recorded. The population estimate is basically obtained using the formula $P = \frac{MC}{R}$; where P is the estimated number of fish,

M is the number initially marked, C is the number of marked and unmarked fish collected during the recapture run, and R is the number of marked fish collected during the recapture run. This formula, although somewhat modified in its final form for statistical reasons, is the basis of the mark-recapture technique.

The numbers of fish are actually estimated by length groups. Those ½ inch length intervals having similar or equal recapture efficiencies comprise a length group. This grouping is necessary because recapture efficiencies are dependent on fish size. Generally, electrofishing is more effective for capturing larger fish due to their greater surface area and their higher visibility when in the electric field. Because recapture efficiencies are length related, the numbers of fish must be estimated by length groups, then added to obtain the total estimate. Generally, at least seven recaptures are needed per length group in order to obtain a statistically valid estimate.

Pounds of fish are obtained by multiplying the average weight of the fish within each length group by the estimated number, then adding to obtain the total pounds. Estimates can also be obtained for different age-groups of fish. This mark-recapture technique, which is thoroughly discussed by Vincent (1971 and 1974), has been adapted for computer analyses by the MDFWP.

Only electrofishing survey data, consisting of the species, numbers and length ranges of captured fish, are provided for those streams in which fish populations could not be sampled efficiently due to low conductivities. Streams in which much of the water is deeper than six feet are also difficult to sample effectively.

Snorkeling

Snorkeling is preferable to electrofishing as a technique for obtaining population densities in streams which have good clarity, low conductivity and are inaccessible by vehicle travel. Snorkeling also is less expensive because it requires a one or two man crew rather than than a three or four man crew and the equipment cost is considerably less than that required for electrofishing. Snorkeling has been used with success in other drainages of high water clarity as reported in Graham et al. (1980).

Underwater observations of fish have often been used for studying the behavior and density of fish (particularly salmonids) in streams. Many researchers have taken underwater counts of fish populations using a single observer (Kennleyside 1962, Reed 1967, Pollard and Bjornn 1973, Everest and Chapman 1972).

Good concentration and peripheral vision are essential when fish numbers are large or when the observer's view is obstructed. If the site is deep on one side, the observer positions himself on the shallow side and looks into the deeper water. Slight modifications of these procedures are necessary when fish are hidden by water turbulence, boulders, log jams, algae mats or undercut banks.

Graham and Sekulich (in preparation) report that snorkeling estimates of cutthroat numbers are comparable to estimates made by various methods of

removal. Northcote and Wilkie (1963) found snorkeling to be an effective method of estimating numbers of several species of fish.

Salmonid density estimates were made in three - five pools in each of seven streams during the summer of 1981. The Kootenai National Forest system for rating pools was used to classify the pools snorkeled (see appendix A). In general, only class one pools were selected to be snorkeled. Surface areas for each pool snorkeled were calculated and average densities per 100 sq ft were estimated for each species by age class.

Trapping Spawning Runs

Spawning runs into tributary streams were sampled using box traps with poultry netting leads and fyke nets. These traps were used successfully to sample runs in the Kootenai drainage (May and Huston 1980).

Mark and recapture data were used to make estimates of the total run ascending the Tobacco River in 1979 and Big Creek in 1980. Fish were caught near the mouth with electrofishing gear and fyke nets, then tagged and released upstream. Box traps and fyke nets were utilized to catch spawners in upstream areas. Spent spawners were collected on their downstream migration using box traps with leads. Population estimates were made using the formula $P=\frac{MC}{R}$; where P is the estimated number of fish, M is the number initially marked from traps and electrofishing gear fished near the mouth, C is the number of marked and unmarked collected in the upstream traps or in the box trap used to capture emigrating spent spawners, and R is the number of marked fish collected in upstream traps or traps which caught emigrating spent spawners. This formula, although somewhat modified in its final form for statistical purposes, is the basis for mark-recapture technique.

The emigration of fry and juvenile rainbow trout was monitored in Bobtail Creek using a fry trap designed by Northcote (1969). The leads were 1/4 inch square mesh hardware cloth.

A modified Wolf Trap was used to sample the emigration of cutthroat trout smolts and spent spawners from Young Creek (Huston and May 1970).

WATER AVAILABILITY

The instream flow recommendations presented in later sections will, if enacted, limit the availability of water for future consumptive users and water development projects. For future planning, it is desirable to define the period in which water in excess of the recommendations is available and to quantify this excess. This information is presented where available in later sections. However, the discussion of water availability is limited for the vast majority of streams since a thorough evaluation requires long-term flow records which are presently lacking for all but a few contract streams.

The discussions of water availability basically consist of comparisons of the monthly flow recommendations to the monthly median and mean flows of record. These statistics provide a measure of the normal or typical flow condition. The median is the flow that is exceeded in 5 of 10 years or in 5 years out of 10 there is more water than the median flowing in the stream. The median is preferred over the mean because it is less readily influenced by unusually high flows which tend to cause the mean to over estimate the norm. The mean rather than the median, however, is more commonly used as an indicator of normal flows because it is an easier statistic to derive.

Although biased by high flows, the monthly means still compare favorably to the medians if derived from long-term gauge records. The similarity of these two values is illustrated in Table 1 which compares the mean and median flows of record on a monthly and annual basis for a typical unregulated stream (Bridger Creek) and river (Big Hole River) of the Upper Missouri drainage of southwest Montana. While monthly means and medians are similar, as indicated in Table 1 , the annual means greatly exceed the annual medians. This is characteristic of unregulated headwater streams and rivers in which a large percentage of the annual water yield is passed during a relatively brief snow runoff period. For these waterways, the median annual flow is vastly superior to the mean annual flow as an indicator of the normal condition. For regulated streams, the annual mean and median values are generally more similar.

Median monthly flows are only available for comparing to the flow recommendations for those streams having at least 9 years of continuous USGS gauge records. While ten years is the minimum period the USGS considers adequate for deriving reliable estimates of monthly medians, a minimum period of 9 years is used for this report. For those streams having one to nine years of continuous flow records or more than 9 years of discontinuous records, the mean monthly flows are substituted. The relatively short period of time for which most of the monthly means were derived detracts somewhat from their reliability as indicators of the norm. These monthly means, while varying in reliability, still provide some insight into water availability and, consequently, are a meaningful addition to the report. For the vast majority of contract streams which are ungauged by the USGS, water availability information is generally limited to a relatively few sporadic flow measurements collected by various state and federal agencies.

Table 1 . Comparison of mean and median flows of record (cfs) derived from USGS gauge records for Bridger Creek and the Big Hole River.

	Bridger Creek[a/]		Big Hole River[d/]	
	Mean[b/]	Median[c/]	Mean[e/]	Median[f/]
Jan	7.2	5.6	349	344
Feb	8.9	6.7	363	328
Mar	15.5	10.5	445	400
Apr	64.7	52.0	1,526	1,290
May	158.0	141.0	3,449	3,150
Jun	104.0	75.5	4,121	3,970
Jul	31.9	28.3	1,347	1,330
Aug	13.6	12.2	482	445
Sep	10.9	9.2	377	305
Oct	10.8	8.9	507	447
Nov	10.3	9.0	508	475
Dec	8.7	6.2	398	348
Annual	36.6	12.0	1,157	480

a/ Bridger Creek near Bozeman, Montana.
b/ Derived for a 24-year period of record (1946-69).
c/ Derived for a 19-year period of record (1950-68).
d/ Big Hole River near Melrose, Montana.
e/ Derived for a 54-year period of record (1924-77).
f/ Derived for a 49-year period of record (1925-73).

The final monthly flow recommendations selected for the streams discussed in later sections of this report generally exceed the normal water availability, as measured by the monthly mean and median flows of record, for the months of November through March. This is the winter period when the natural flows are lowest for the year. These naturally occurring low flows, when coupled with the adverse effects of surface and anchor ice formation and the resulting scouring of the river channel at ice-out, can impact the fishery. Consequently, water depletions during this crucial low flow period have the potential to be extremely harmful to the already stressed trout populations. If trout populations are to be maintained at existing levels, little or no water should be removed during the crucial winter period.

1. STREAM

Bobtail Creek from its confluence with the Kootenai River about three miles downstream from Libby, Montana (T31N, R31W, Sec. 30) to the junction of Bull Creek (T31N, R31W, Sec. 5).

2. DESCRIPTION

Stream Length

Mouth of Bobtail Creek to Bull Creek: 5.1 miles
Perennial stream in drainage: 13.0 miles

Drainage Area

Total Bobtail Creek: 22.1 square miles

Gradient

Mouth to Bull Creek: 98.0 feet per mile

Origin and Land Use

Bobtail Creek has its origin on the southwest slopes of the Purcell Mountains and flows south for approximately ten miles to the Kootenai River. Most of the drainage is in the Kootenai National Forest. About seven sections of land within the drainage are privately owned. Timber production is the primary land use in the drainage.

Flows

Little flow data have been collected on Bobtail Creek except for sporadic measurements taken by personnel of the Kootenai National Forest.

Water Quality

Bobtail Creek has a $B\text{-}D_1$ classification under the State Water Quality Standards. Waters classified $B\text{-}D_1$ are suitable for drinking, culinary and food processing purposes after adequate treatment equal to coagulation, sedimentation, filtration, disinfection and any additional treatment necessary to remove naturally present impurities; bathing, swimming and recreation; growth and propagation of salmonid fishes and associated life, waterfowl and furbearers; and agricultural and industrial water supply.

Recreational Usage

Angler use of Bobtail Creek is comparatively low due to poor access and the small size of the fish in the resident population. Hunting is a major activity in the drainage with elk, whitetail deer and mountain grouse the primary species harvested.

Potential Environmental Problems

The irrigation of pasture land, gardens and lawns has already caused de-

watering problems in Bobtail Creek. Increased land development will probably result in more water diversions in the future. Timber harvesting could increase sediment loads and peak flows, causing channel stability problems and damage to the fish habitat.

3. FISHERIES MANAGEMENT

Stream surveys conducted from 1976-1978 indicated that about 9.1 miles of spawning habitat is present in Bobtail Creek. The spawning habitat is classified into three categories; good (5.9 miles), fair (1.6 miles) and poor (1.6 miles). Several potential barriers to migrating fish were removed from Bobtail Creek and its major tributary, Bull Creek.

The protection of water quality and fish habitat has been a management priority in the Bobtail drainage. Logging, road construction and stream crossings have been reviewed with the Kootenai National Forest and private landowners to minimize the effects of these activities upon water quality and fish habitat.

4. FISH POPULATIONS

The spawning run of rainbow trout ascending Bobtail Creek from the Kootenai River was sampled with box traps from 1978-1980 (Table 2). The number of fish caught in the trap varied from 155 spawners in 1978 to 379 spawners in 1979. These numbers represent a minimum estimate of the run of rainbow trout, because the trap operation was not 100 percent efficient.

The average length of the spawners has decreased from 1978-1980. Females averaged 16.3 inches in total length in 1978 as compared to 13.6 inches in 1980. The decline in average size is primarily due to reduced growth rates of rainbow trout in the Kootenai River from 1978-1980 (May and Huston 1981).

The emigration of rainbow trout fry and smolts was monitored in 1978 and 1979. The total number of smolts annually emigrating from Bobtail Creek was estimated to be approximately 5,000-7,000 fish (May and Huston 1979).

The data concerning the rainbow trout spawning runs and the production of smolts indicate that Bobtail Creek is an extremely important spawning and nursery stream for rainbow trout from the Kootenai River.

5. FLOW RECOMMENDATIONS

Cross-sectional measurements were made in a series of five riffle areas of Bobtail Creek, approximately one mile upstream from its confluence with the Kootenai River (T31N, R31W, Sec. 20). The WETP program was calibrated to field data collected at flows of 3.8, 5.7 and 22.0 cfs. The lower and upper inflection points on the wetted perimeter discharge relationship occur at flows of about 5 and 9 cfs, respectively (see Figure 5). Based on an evaluation of existing fishery, recreational use, water availability and other resource information, a flow of 5 cfs is recommended for the low flow period from July 1 through March 31.

The flow required to insure fish passage for the spring spawning run of rainbow trout is 16 cfs (Table 3). The average depth for all five riffles

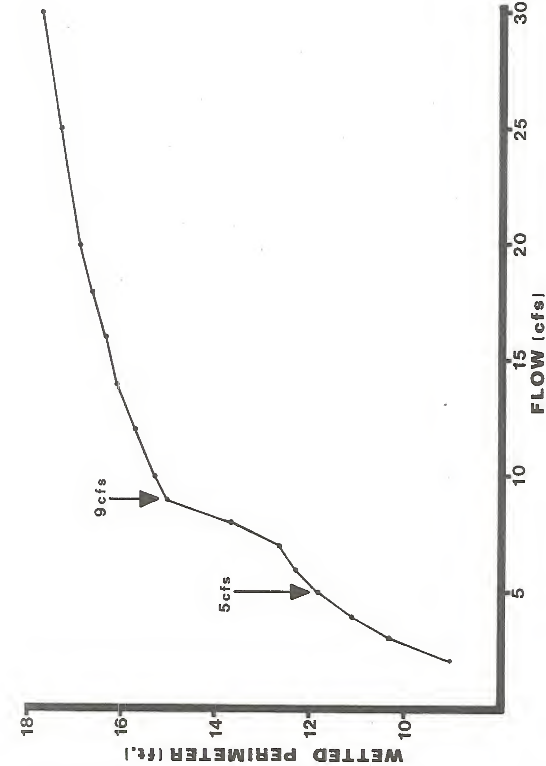

Figure 5. The relationship between wetted perimeter and flow for a composite of five riffle cross-sections in Bobtail Creek.

Table 2. Summary of rainbow trout spawning runs into Bobtail Creek from the Kootenai River, 1978-1980.

	YEAR		
Parameter	1978	1979	1980
Period Trap Operated	3/21-5/8	3/22-6/4	3/26-6/1
Peak of Run	4/8-5/2	4/21-5/25	4/14-5/22
Days Leads Up	33	77	54
Number Males	117	188	143
Number Females	38	190	62
Total Run	155	378	305
Average Length Males (inches)	11.7	11.3	10.3
Average Length Females (inches)	16.3	14.0	13.6

Table 3. The average depth for five riffle cross-sections in Bobtail Creek at selected flows of interest.

	Average Depth (ft)				
Flows (cfs)	Riffle #1	Riffle #2	Riffle #3	Riffle #4	Riffle #5
5	.42	.67	.40	.53	.42
10	.53	.64	.42	.64	.59
16	.59	.76	.51	.72	.69

at this flow exceeds 0.5 ft, the approximate minimum depth required for successful passage. A passage flow of at least 16 cfs should be maintained from April 1 through June 30.

Due to the lack of long term flow data, recommendations based on the dominant discharge/channel morphology concept cannot be derived for Bobtail Creek.

1. STREAM

East Fork of the Bull River from its confluence with the Bull River (T27N, R33W, Sec. 12) upstream to the junction of the East and North Forks (T27N, R32W, Sec. 4).

2. DESCRIPTION

Stream Length

Mouth of East Fork to confluence with the North Fork: 4.5 miles

Drainage Area

Total East Fork: 28.0 square miles

Gradient

Mouth to North Fork: 124.4 feet per mile

Origin and Land Use

The East Fork of the Bull River arises on the west slopes of the Cabinet Mountains and flows approximately 9 miles west to its confluence with the Bull River. The upper part of the drainage is located in the Cabinet Mountains Wilderness Area. Except for approximately one section of land near the mouth, the entire drainage is in the Kootenai National Forest. Timber production is currently the primary land use. Mining activity is anticipated within the drainage in the near future.

Flows

Little flow data have been collected on the East Fork of the Bull River, except for sporadic measurements taken by personnel of the Kootenai National Forest.

Water Quality

The East Fork of the Bull River has a B-D_1 classification under the State Water Quality Standards. Waters classified B-D_1 are suitable for drinking, culinary and food processing purposes after adequate treatment equal to coagulation, sedimentation, filtration, disinfection and any additional treatment necessary to remove naturally present impurities; bathing, swimming and recreation; growth and propagation of salmonid fishes and associated life, waterfowl and furbearers; and agricultural and industrial water supply.

The limited water quality data collected on the East Fork indicate that it is a soft water stream with low buffering capabilities. The total alkalinity has ranged from 40-83 mg/l and the pH has averaged 7.7.

Recreational Usage

A fishing pressure survey conducted in 1975 produced an estimate of 736 man days of angling on the Bull River drainage (MDFG 1976). A substantial part of this took place in the East Fork of the Bull River.

The East Fork drainage has good populations of big game animals and moun-

tain grouse. A considerable amount of big game hunting occurs in the drainage. Species harvested include white-tailed deer, mule deer, elk, black bear, mountain goats and bighorn sheep.

The upper part of the drainage in the Cabinet Mountains Wilderness Area provides high quality back country recreation for people who enjoy hiking, mountain climbing and the solitude of a wilderness environment.

Potential Environmental Problems

The greatest threat to the aquatic environment of the East Fork is the potential for the development of mines in the upper drainage. Mining activities could increase sediment loads and lead to metals pollution.

Increased sediment loads resulting from timber harvesting in the drainage could reduce the productivity of the East Fork and cause channel stability problems.

3. FISHERIES MANAGEMENT

The fisheries management program for the drainage has pertained to the coordination of timber sales with the Kootenai National Forest to minimize the effects of logging and associated road building on water quality and fish habitat.

4. FISH POPULATIONS

The East Fork of the Bull River supports populations of resident trout and provides spawning and nursery habitat for cutthroat trout, bull trout and brown trout from Cabinet Gorge Reservoir. Little is known about the runs of cutthroat and bull trout.

Brown trout begin ascending the Bull River in mid-October and spawning occurs in the East Fork from the first or second week of November until the end of December. Twenty-four brown trout redds were observed in 1980 in the East Fork and the count increased to forty-one in 1981.

The results of an underwater fish survey conducted on three class one pools having a total surface area of 5,820 sq ft are shown in Table 4. Game fish species observed were brook trout (41), cutthroat trout (35), mountain whitefish (16) and bull trout (6). The failure to observe brown trout during the survey suggests that nearly all the brown trout must emigrate to the reservoir during their first summer of life. The number of trout (1.72) observed per 100 sq ft of pool surface area indicates that the East Fork supports a fairly dense population of trout for a soft water stream.

Table 4. The number of cutthroat trout, brook trout, bull trout and mountain whitefish observed in August, 1981 during an underwater fish census in three class one pools in the East Fork of the Bull River (T27N, R32W, Sec. 7).

Length Group in Inches	Assigned Age	Total Number Counted	Number Per 100 Sq Ft of Pool Surface Area
		Cutthroat Trout	
3.0 - 6.9	1 & 2	12	0.25
7.0 - 14.0	2 - 5	23	0.48
		35	0.73
		Brook Trout	
3.0 - 6.9	1 & 2	33	0.69
7.0 - 14.0	2 - 5	8	0.17
		41	0.86
		Bull Trout	
3.0 - 6.9	1 - 3	6	0.13
		Mountain Whitefish	
7.0 - 16.0	2 - 7	16	0.33
Total Trout		77	1.72

5. FLOW RECOMMENDATIONS

Cross-sectional measurements were made in a series of four riffle areas of the East Fork of the Bull River approximately one mile upstream from its mouth (T27N, R32W, Sec. 7). The WETP program was calibrated to field data collected at flows of 18.2, 34.7 and 386.4 cfs. The lower and upper inflection points on the wetted perimeter-discharge relationship occur at flows of about 20 and 40 cfs, respectively (see Figure 6). Based on an evaluation of existing fishery, recreational use, water availability and other resource information, a flow of 30 cfs is recommended for the low flow period from July 1 through March 31.

The average depth of the four riffle cross-sections exceeds 0.5 ft, the approximate minimum depth required for trout passage, at a flow of approximately 20 cfs (see Table 5). Since the 30 cfs recommendation for the low flow

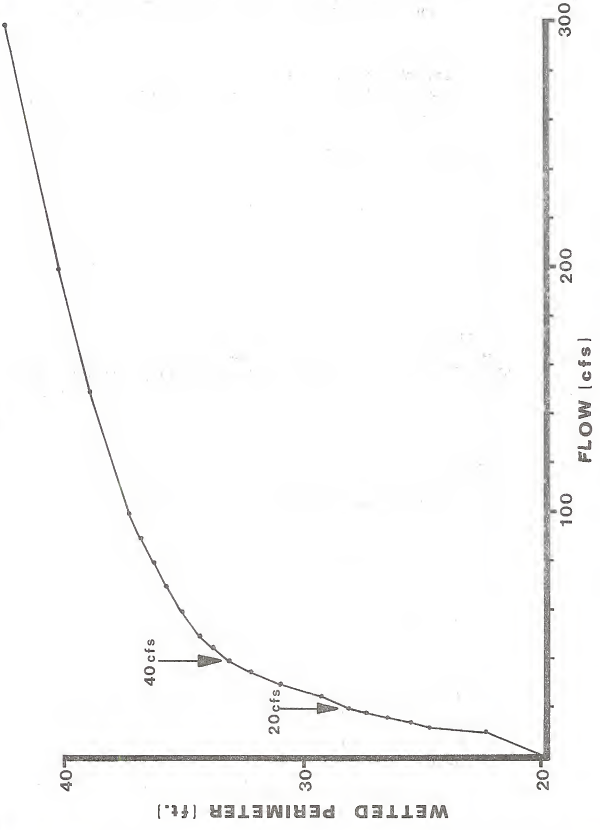

Figure 6. The relationship between wetted perimeter and flow for a composite of four riffle cross-sections in the East Fork of the Bull River.

period exceeds the 20 cfs passage recommendation, a flow of at least 30 cfs is being recommended year-round for the East Fork of the Bull River.

Table 5. The average depth (ft) for four riffle cross-sections in the East Fork of the Bull River at selected flows of interest.

Flow (cfs)	Average Depth (ft)			
	Riffle #1	Riffle #2	Riffle #3	Riffle #4
10	.37	.47	.65	.54
20	.61	.61	.91	.72
30	.78	.72	1.01	.84

1. STREAM

Fortine Creek from its confluence with Graves Creek, about 10 miles east of Eureka, Montana (T35N, R26W, Sec. 15), upstream to the junction of Edna Creek (T33N, R26W, Sec. 2).

2. DESCRIPTION

Stream Length

Mouth Fortine Creek to confluence of Edna Creek: 12.8 miles
Perennial stream in drainage: 150 miles

Drainage Area

Total Fortine Creek: 180 square miles

Gradient

Mouth upstream 12.5 miles to Swamp Creek: 49.0 feet per mile

Origin and Land Use

Fortine Creek originates on the east slopes of the Salish Mountains in Lincoln County and flows approximately 27 miles north and west to its confluence with Graves Creek. Approximately 70 percent of the drainage is in the Kootenai National Forest with the remainder in private and state ownership. Timber production is the primary land use in the drainage, but there are also a considerable number of small farms and ranches in the lower part of the drainage.

Flows

Little flow data have been collected on Fortine Creek, except for sporadic measurements taken by personnel of the Kootenai National Forest.

Water Quality

Fortine Creek has a B-D_1 classification under the State Water Quality Standards. Waters classified B-D_1 are suitable for drinking, culinary and food processing purposes after adequate treatment equal to coagulation, sedimentation, filtration, disinfection and any additional treatment necessary to remove naturally present impurities; bathing, swimming and recreation; growth and propagation of salmonid fishes and associated life, waterfowl and furbearers; and agricultural and industrial water supply.

Fortine Creek is one of the more productive streams in Lincoln County with a total alkalinity of about 188 mg/l in the summer and a pH of 8.00.

Recreational Usage

A fishing pressure survey conducted in 1975 showed an estimated 161 man-days of angling on Fortine Creek (MDFG 1976). Hunting is also a popular recreational activity within the drainage with elk, mule deer, white-tailed deer, moose, black bear and mountain grouse harvested.

Potential Environmental Problems

Potential problems include stream dewatering due to diversions for agricultural and housing developments and increased sediment loads relating to logging activities and cattle grazing.

3. FISHERIES MANAGEMENT

The fisheries management program for Fortine Creek has been concerned with habitat and water quality protection and the enhancement of cutthroat and rainbow trout spawning runs from Lake Koocanusa. Potential barriers to the upstream movement of cutthroat and rainbow trout have been removed and imprint plants of approximately 254,670 sub-fingerling westslope cutthroat trout were made in the drainage from 1973 to 1980.

4. FISH POPULATIONS

The spawning run of rainbow and cutthroat trout ascending Fortine Creek in 1979 was sampled (Table 6). A fyke trap fished near the mouth of Fortine Creek caught 14 rainbow trout and only one cutthroat trout. The efficiency of the fyke net was low and only a small part of the run was sampled.

A total of 14 rainbow trout was captured in a box trap fished in Meadow Creek, a small tributary of Fortine Creek, from May 8 to 23. The trap efficiency was almost 100 percent due to the low flows, but the early part of the rainbow run was missed.

Table 6. Summary of fish trap catches in the Fortine Creek Drainage during the rainbow and cutthroat trout spawning runs in Spring, 1979. Abbreviations for capture method are: B=box trap and F=fyke net.

Location and Capture Method	Number Caught		Period Trap Operated
	Cutthroat	Rainbow	
Fortine Creek (F)	1	14	5/5 - 6/4
Meadow Creek (B)	-	14	5/7 - 6/3
Deep Creek (B)	5	3	4/12 - 6/3

A box trap was fished in Deep Creek, another tributary, from April 12 to June 3, but only five cutthroat and three rainbow trout were caught. High water forced the trap leads down on 15 days during the peak of the run, resulting in a low trap efficiency. The run of spawners into this stream was much higher than indicated by the trap catch.

The actual run of cutthroat and rainbow trout into the Fortine drainage could not be determined in 1979 due to low trap efficiencies. The total run in most years may be as high as 1,000-2,000 fish. Fortine Creek is one of the two major tributaries of the Tobacco River, which had an estimated spawning run of 7,000 rainbow and cutthroat trout in 1979 (May and Huston 1980).

An attempt was made in August, 1981 to determine fish densities in Fortine Creek using the snorkeling technique, but visibility was poor and accurate counts could not be made.

5. FLOW RECOMMENDATIONS

Cross-sectional measurements were made in a series of five riffle areas of Fortine Creek, approximately three miles upstream from its confluence with Graves Creek (T35N, R26W, Sec. 25). The WETP program was calibrated to field data collected at flows of 32.4, 47.5 and 205.3 cfs. The lower and upper inflection points on the wetted perimeter discharge-relationship occur at flows of about 22 and 38 cfs, respectively (see Figure 7). Based on an evaluation of existing fishery, recreational use, water availability and other resource information, a flow of 25 cfs is recommended for the low flow period from July 1 through March 31.

The flow required to insure fish passage during the spring spawning run is approximately 30 cfs (Table 7). The average depth for all five riffle cross-sections at this flow exceeds 0.5 ft, the approximate minimum depth required for successful passage. A passage flow of at least 30 cfs should be maintained from April 1 through June 30.

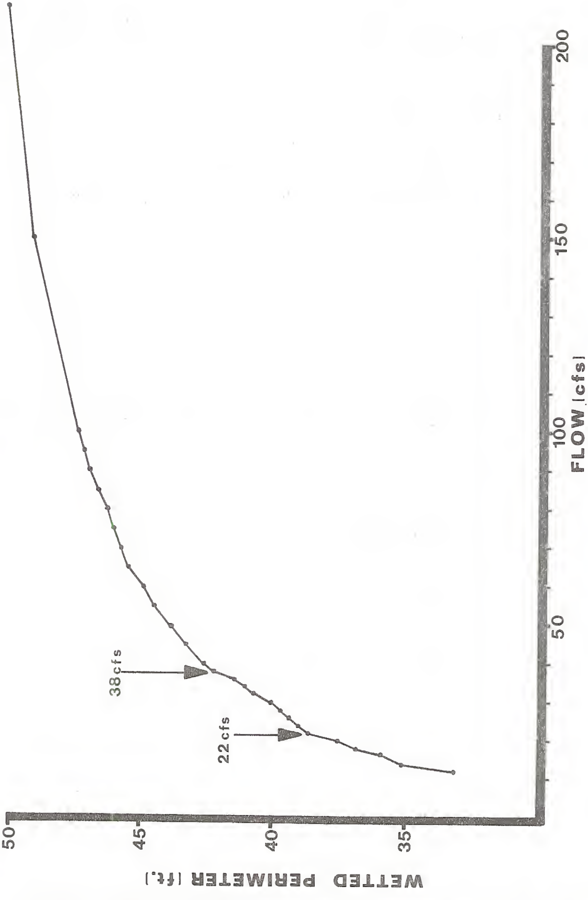

Figure 7. The relationship between wetted perimeter and flow for a composite of five riffle cross-sections in Fortine Creek.

Due to the lack of long term flow data, recommendations based on the dominant discharge/channel morphology concept cannot be derived for Fortine Creek.

Table 7. The average depth for five riffle cross-sections in Fortine Creek at selected flows of interest.

	Average Depth (ft)				
Flow (cfs)	Riffle #1	Riffle #2	Riffle #3	Riffle #4	Riffle #5
20	.41	.38	.54	.47	.60
24	.47	.43	.63	.49	.67
30	.56	.50	.73	.55	.75

1. STREAM

Libby Creek from its confluence with the Kootenai River at Libby, Montana (T30N, R31W, Sec. 3) upstream to the junction of Bear Creek (T28N, R30W, Sec. 18)

2. DESCRIPTION

Stream Length

Mouth Libby Creek to confluence of Bear Creek: 18.0 miles
Perennial stream in drainage: 148.0 miles

Drainage Area

Total Libby Creek: 227.5 square miles

Gradient

Mouth to Howard Creek: 74.1 feet per mile

Origin and Land Use

Libby Creek arises on the east slopes of the Cabinet Mountains and flows in a northeasterly direction for about 27 miles to its confluence with the Kootenai River. The upper part of the drainage is in the Cabinet Mountains Wilderness Area. About 85 percent of the drainage is in the Kootenai National Forest, with the remainder in private and state ownership. Timber production is the primary land use in the drainage. Much of the bottom land in the lower 10-15 miles has been subdivided into 1-10 acre plots. The lower mile of stream runs adjacent to a St. Regis Paper Company lumber mill.

Flows

Little flow data have been collected on Libby Creek except for sporadic measurements taken by personnel of the Kootenai National Forest.

Water Quality

Libby Creek has a B-D_1 classification under the State Water Quality Standards. Waters classified B-D_1 are suitable for drinking, culinary and food processing purposes after adequate treatment equal to coagulation, sedimentation, filtration, disinfection and any additional treatment necessary to remove naturally present impurities; bathing, swimming, and recreation; growth and propagation of salmonid fishes and associated life, waterfowl and furbearers; and agricultural and industrial water supply.

Libby Creek is a relatively infertile stream with alkalinity ranging between 25 and 87 ppm and a pH of 7.7.

Recreational Usage

A fishing pressure survey conducted in 1975 showed an estimated 1,072 man-days of angling on Libby Creek (MDFG 1976). Hiking, berry picking and hunting are other recreational activities in the drainage. Game species harvested include moose, elk, white-tailed deer, mule deer, mountain goats, black bear and ruffed blue and Franklin grouse.

Potential Environmental Problems

Libby Creek is a high water yield drainage. Man's activities in the drainage have increased peak flows and sediment loads, resulting in channel stability problems. Timber production and associated road building, and removal of vegetation from the flood plain for pasture and housing developments have been major factors contributing to the channel stability problem.

Heavy metals pollution from an abandoned mine and mill on Snowshoe Creek is limiting aquatic productivity in Snowshoe and Big Cherry creeks, tributaries to Libby Creek.

Water withdrawals for mining subdivisions and agricultural developments could cause severe dewatering problems in the future.

3. FISHERIES MANAGEMENT

The protection of water quality and fish habitat and the improvement of channel stability have been the management priorities in the drainage. Close cooperation has been maintained with the Kootenai National Forest to try and minimize the effects of logging on water quality and fish habitat. Numerous channel stability projects on private land have been reviewed with the Lincoln County Conservation District.

The Kootenai National Forest has an active program to remove log and debris jams which might block the upstream movement of spawning runs of salmonids.

4. FISH POPULATIONS

Data collected from the rainbow trout spawning run ascending Libby Creek from the Kootenai River are presented in Table 8. Only a small part of the run was sampled each year due to high flows which prevented operation of the fish trap during much of the spawning run. Based on the number of fish caught per day of trap operation, it appears that the run was larger in 1981 than in 1976 and 1977. This is in agreement with electrofishing data which indicate that the rainbow trout population in the mainstem Kootenai River has increased by 300 percent from 1977 to 1981 (May and et al. 1981). Libby Creek probably supports a run of 400-1,000 rainbow trout and is the most important spawning and nursery tributary downstream from Libby Dam.

Table 8. Summary of data for rainbow trout spawning runs form the Kootenai River into Libby Creek in 1976, 1977 and 1981.

Time Interval Trap in Operation	Days Trap in Operation	Number of Spawners	Number of Spawners Caught per Day of Trap Operation	Average Length (in) Males	Average Length (in) Females
Mar 24-Apr 5, 1976	13	49	3.8	16.1	18.6
Mar 14-Apr 27, 1977	23	49	2.1	16.2	19.1
Apr 16-Apr 24, 1981	8	67	8.4	14.5	15.5

The average size of males and females declined markedly from 1976 to 1981. Females averaged 19.1 inches in total length in 1977, as compared to only 15.5 inches in 1981. The decline in average size is due primarily to a reduction in the growth rates of trout in the Kootenai River (May and et al. 1981).

A population estimate using mark and recapture data was made on a two mile section of Libby Creek in 1977. The estimate of 259 yearling and older rainbow trout per thousand feet of stream (Table 9) indicates that Libby Creek supports a dense fish population. Age one fish dominated the population, comprising 85.7 percent of the estimated numbers.

Table 9. Rainbow trout population estimates for Libby Creek (T30N, R31W, Sec. 36) in 1977. Estimates are given as number and weight of fish per thousand feet of stream. The 80 percent confidence limits are given in parenthesis.

Age	Average Length (in)	Average Weight (lb)	Age Composition (%)	Number per Thousand Feet	Pounds per Thousand Feet
1	4.7	.04	85.7	222	9.0
2	7.0	.13	13.9	36	4.7
3 & older	13.0	1.07	0.4	1	1.1
				259 (±18.9%)	14.8

5. FLOW RECOMMENDATIONS

Cross-sectional measurements were made in four riffle areas of Libby Creek approximately 13 miles upstream from its confluence with the Kootenai River (T28N, R30W, Sec. 5). The WETP program was calibrated to field data collected at flows of 8.4, 41.7 and 370.1 cfs. The lower and upper inflection points on the wetted perimeter-discharge relationship occur at flows of about 9 and 45 cfs, respectively (see Figure 8). Based on an evaluation of existing fishery, recreational use, water availability and other resource information, a flow of 15 cfs is recommended for the low flow period from July 1 through March 31.

The flow required to insure fish passage for the spring spawning run of rainbow trout is approximately 30 cfs (Table 10). The average depth for all four riffle cross-sections at this flow exceeds 0.5 ft, the approximate minimum depth required for successful passage. The passage flow of at least 30 cfs should be maintained from April 1 through June 30.

Due to the lack of long term flow data, recommendations based on the dominant discharge/channel morphology concept cannot be derived for Libby Creek.

Table 10. The average depth for four riffle cross-sections in Libby Creek at selected flows of interest.

	Average Depth (ft)			
Flow (cfs)	Riffle #1	Riffle #2	Riffle #3	Riffle #4
10	.61	.30	.15	.34
20	1.03	.50	.40	.56
30	1.20	.57	.53	.70

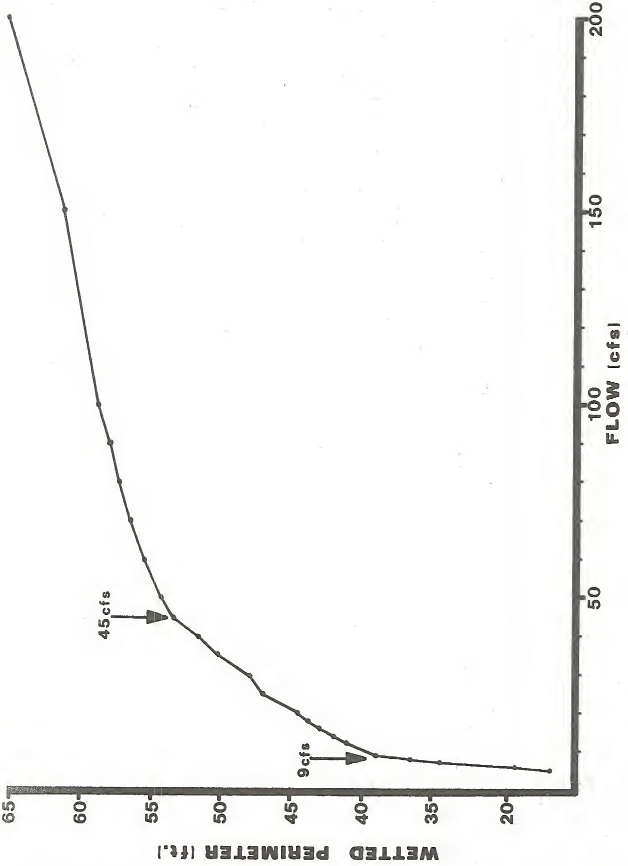

Figure 8. The relationship between wetted perimeter and flow for a composite of four riffle cross-sections in Libby Creek.

1. STREAM

O'Brien Creek from its confluence with the Kootenai River (T31N, R33 W, Sec. 18) near Troy, Montana upstream to the junction of the North Fork (T32N, R33W, Sec. 7).

2. DESCRIPTION

Stream Length

Mouth O'Brien Creek to the North Fork: 12 miles
Perennial stream in drainage: 32 miles

Drainage Area

Total O'Brien Creek: 49.5 square miles

Gradient

Mouth to North Fork: 80.8 feet per mile

Origin and Land Use

O'Brien Creek arises on the west slopes of the Purcell Mountains and flows west then south for approximately 16 miles to its confluence with the Kootenai River. Approximately 82 percent of the drainage is in the Kootenai National Forest with the remainder in private ownership. Timber production is the primary land use in the drainage.

Flows

Little flow data have been collected on O'Brien Creek, except for sporadic measurements taken by personnel of the Kootenai National Forest.

Water Quality

O'Brien Creek has a B-D_1 classification under the State Water Quality Standards. Waters classified B-D_1 are suitable for drinking, culinary, and food processing purposes after adequate treatment equal to coagulation, sedimentation, filtration, disinfection and any additional treatment necessary to remove naturally present impurities; bathing, swimming and recreation; growth and propagation of salmonid fishes and associated life, waterfowl and furbearers; and agricultural and industrial water supply.

O'Brien Creek is a fairly productive stream having a pH of 8.0 and a total alkalinity of 105 mg/l during the late summer and fall.

Recreational Usage

The primary recreational uses in the O'Brien Creek drainage are fishing and hunting. Cutthroat and brook trout are the species creeled by anglers. Game species hunted include white-tailed deer, mule deer, elk, black bear and mountain grouse.

Potential Environmental Problems

A proposed micro-hydro project on O'Brien Creek could dewater the lower part of O'Brien Creek and also hinder the downstream movement of rainbow trout smolts.

Timber harvesting and new logging roads in the drainage have the potential to markedly increase sediment loads, unless sound erosion control practices are enforced.

3. FISHERIES MANAGEMENT

A survey of streams tributary to the Kootenai River from Kootenai Falls to the Idaho border showed that spawning and rearing habitat appeared to be limiting rainbow trout populations (May & Huston 1979). Natural falls and man-made barriers limited access into all major streams. O'Brien Creek was determined to have about 16 miles of good spawning and nursery habitat for rainbow trout, but access was blocked by an old mill pond dam. This dam was removed in October, 1978 and imprint plants of wild rainbow trout eggs were made in the drainage in 1979 and 1980. O'Brien Creek could develop into the most important spawning and nursery tributary for rainbow trout in the Kootenai River downstream from Kootenai Falls.

Other management activities in the drainage have centered around water quality and habitat protection in cooperation with the Kootenai National Forest.

4. FISH POPULATIONS

The fish densities in O'Brien Creek were determined in 1979 using electrofishing gear (Table 11) and again in 1981 using the snorkeling technique (Table 12). The westslope cutthroat trout was the only game fish collected or observed in large numbers. Other species included bull trout, brook trout, rainbow X cutthroat hybrids, rainbow trout and slimy sculpins. The density of cutthroat trout was higher in class one pools (2.27 fish/100 sq ft of pool) than in the electrofishing estimate (1.08 fish /100 sq ft of surface area), which included all habitat types. These densities indicate that the production of westslope cutthroat trout in O'Brien Creek is higher than most streams in the area.

Table 11. Population estimates by length groups and approximate age classes for cutthroat trout in a 1,000 ft long section of O'Brien Creek (T32N, R33W, Sec. 32), in August, 1979. The 80 percent confidence limits are given in parentheses.

Length Group	Assigned Age	Percent Age Composition	Average Length (in)	Average Weight (lb)	Per 100 sq ft of Surface Area	
					Number	Weight
3.0-4.9	1	72.8	4.3	.03	.79	-
5.0-6.9	2	12.3	5.6	.07	.13	-
7.0-10.8	3 & 4	14.9	8.1	.21	.16	-
TOTAL					1.08(±24.0%)	0.07

Table 12. The number of cutthroat trout observed in August, 1981 during an underwater fish census in three class one pools in O'Brien Creek (T32N, R33W, Sec. 32).

Length Group in Inches	Approximate Age	Total Number Counted	Number Per 100 sq ft of Pool Surface Area
3.0-6.9	1 & 2	33	1.97
7.0-9.0	3 - 5	5	.30
Total		38	2.27

5. FLOW RECOMMENDATIONS

Cross-sectional measurements were made in a series of five riffle areas of O'Brien Creek, approximately four miles upstream from its confluence with the Kootenai River (T32N, R33W, Sec. 32). The WETP program was calibrated to field data collected at flows of 14.3, 26.6 and 141.7 cfs. The lower and upper inflection points on the wetted perimeter-discharge relationship occur at flows of about 14 and 30 cfs, respectively (see Figure 9). Based on an evaluation of existing fishery, recreational use, water availability and other resource information, a flow of 20 cfs is recommended for the low flow period from July 1 through March 31.

The flow required to insure fish passage for spring spawning runs of rainbow trout is 30 cfs (Table 13). The average depth for all five riffles at this flow exceeds 0.5 ft, the approximate minimum depth required for successful trout passage. A passage flow of at least 30 cfs should be maintained from April 1 through June 30.

Due to the lack of long term flow data, recommendations based on the dominant discharge/channel morphology concept cannot be derived for O'Brien Creek.

Table 13. The average depth for five riffle cross-sections in O'Brien Creek at selected flows of interest.

	Average Depth (ft)				
Flow (cfs)	Riffle #1	Riffle #2	Riffle #3	Riffle #4	Riffle #5
10	.44	.43	.22	.69	.40
20	.67	.58	.47	.75	.60
30	.74	.67	.56	.78	.70

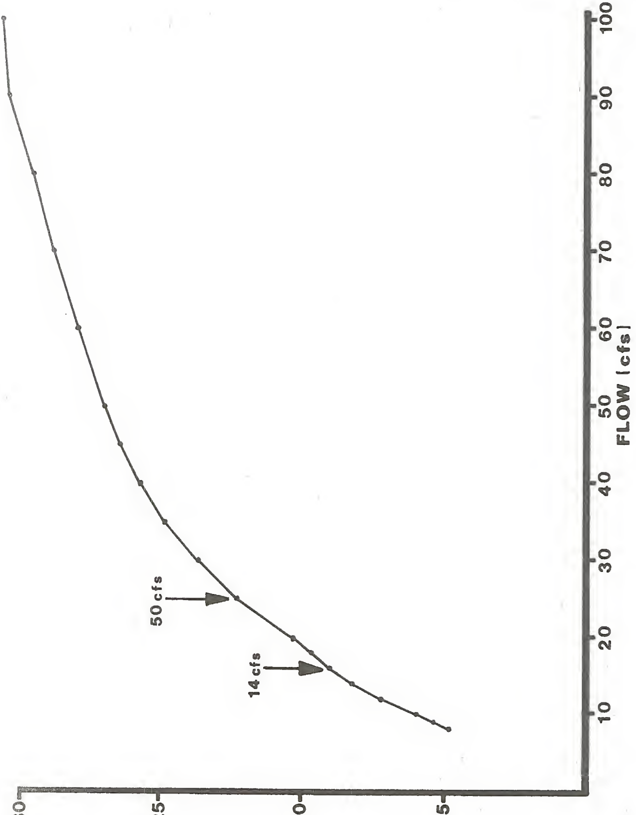

Figure 9. The relationship between wetted perimeter and flow for a composite of five riffle cross-sections in O'Brien Creek.

1. STREAM

Pinkham Creek from its confluence with Lake Koocanusa south of Rexford, Montana (T35N, R28W, Sec. 5) upstream to the junction of the East and West Forks of Pinkham Creek (T34N, R27W, Sec.32)

2. DESCRIPTION

Stream Length

Mouth Pinkham Creek to East & West Forks:	20 miles
Perennial stream in drainage:	37 miles

Drainage Area

Total Pinkham Creek: 75.7 sq. mi.

Gradient

Mouth to East and West Forks: 108.0 ft. per mi.

Origin and Land Use

Pinkham Creek arises on the west slopes of the Salish Mountains in Lincoln County and flows approximately 20 miles north and west to its confluence with Lake Koocanusa. Approximately 85% of the drainage is in the Kootenai National Forest, with the remainder in private (13%) and state (2%) ownership. Timber production is the primary land use in the drainage. Several small ranches and farms in the drainage produce hay and cattle.

Flows

The USGS has operated a gage near the mouth of Pinkham Creek since October 1972. During this period, flows have ranged from no flow to a high of 689 cfs on May 11, 1976. The average discharge is 24.7 cfs. Pinkham Creek has a severe dewatering problem in the lower 2-3 miles due to the stream going underground. The period of no flow usually occurs from September-November. Although surface flow may cease, sufficient groundwater is usually available to keep fish alive in pool areas.

Water Quality

Pinkham Creek has a $B\text{-}D_1$ classification under the State Water Quality Standards. Waters classified $B\text{-}D_1$ are suitable for drinking, culinary, and food processing purposes after adequate treatment equal to coagulation, sedimentation, filtration, disinfection and any additional treatment necessary to remove naturally present impurities, bathing, swimming and recreation, growth and propagation of salmonid fishes and associated life, waterfowl and furbearers; and agricultural and industrial water supply.

Pinkham Creek is a fertile stream, with a total alkalinity of about 150 ppm in the late summer and a pH of 8.2.

Recreational Use

A fishing pressure survey conducted in 1975 showed an estimated 223 mandays of angling on Pinkham Creek (MDFG 1976). Rainbow and brook trout are the main species harvested.

Hunting is a popular activity in the drainage. The Pinkham Creek drainage supports one of the larger moose populations in northwestern Montana, along with elk, mule deer, white-tailed deer, black bear and mountain grouse.

Potential Environmental Problems

The lower 2-3 miles of Pinkham Creek have a dewatering problem due to the stream going underground in the late summer and fall. Water diversions for irrigation or subdivisions would compound this problem.

Timber harvesting in the drainage has the potential to increase sediment loads and peak flows which would adversely affect stream stability and fish habitat. Cattle grazing has caused some erosion and bank stability problems.

3. FISHERIES MANAGEMENT

Pinkham Creek has a falls approximately 6 miles upstream from its mouth. The stream downstream from the falls has been managed primarily as a spawning and nursery area for cutthroat and rainbow trout from Lake Koocanusa. The initial developmental work took place in 1973 and involved the removal of barriers to upstream fish movement, the elimination of resident stocks of fish, and imprint plants of subfingerling westslope cutthroat trout. A total of 95,700 cutthroat were planted from 1973 to 1980.

The protection of fish habitat and water quality have also been a management priority for the drainage. The program has involved working with the Kootenai National Forest to minimize the effects of logging and road building upon the aquatic resource.

4. FISH POPULATIONS

The program to enhance cutthroat trout spawning runs in Pinkham Creek was successful. The number of redds (spawning beds) located in 1977 and 1978 was 231 and 135, respectively (May and Huston 1979). Most females make only one redd and the sex ratio of cutthroat spawners in Lake Koocanusa tributaries has ranged from 1.0 male:1.6 females to 1.0 male:4.8 females. Based on this information, the cutthroat run into Pinkham Creek is probably in the range of 400-600 fish in most years.

Five class one pools having a total area of 2,590 sq. ft. were snorkeled to determine resident fish densities in Pinkham Creek above the falls. The rainbow trout was the most numerous salmonid observed, comprising 92 percent of the trout in the pools with the remainder consisting of brook trout. The density of 6.41 trout per 100 sq. ft. of pool surface area (Table 14) was the highest recorded in any stream in Lincoln County. Pinkham Creek supports an excellent population of resident rainbow trout above the falls.

Table 14. Number of rainbow and brook trout observed in August 1981 during an underwater fish census in five class one pools in Pinkham Creek (T36N, R27W, Sec. 31).

Length Group in Inches	Approximate Age	Total Number Counted	Number/100 sq. ft. of Pool Surface Area
	Rainbow Trout		
3.0 - 6.9	1 & 2	138	5.37
7.0 -11.0	3 & 4	14	0.54
		153	5.91
	Brook Trout		
3.0 - 6.9	1 & 2	11	0.42
7.0 - 9.0	3 & 4	2	0.08
		13	0.50
Total		166	6.41

5. FLOW RECOMMENDATIONS

Cross-sectional measurements were made in a series of five riffle areas of Pinkham Creek, approximately 7 miles upstream from its confluence with Lake Koocanusa (T36N, R27W, Sec. 31). The WETP program was calibrated to field data collected at flows of 4.6, 8.3 and 165.5 cfs. The lower and upper inflection points on the wetted perimeter-discharge relationship occur at flows of about 5 and 14 cfs, respectively (Figure 10). Based on an evaluation of existing fishery, recreational use, water availability and other resource information, a flow of 5 cfs is recommended for the low flow period from July 1 through March 31.

The dominant discharge/channel morphology concept was used to determine the flows during the high flow period from April 1 through June 30, rather than the fish passage criteria. The high flows that are needed to maintain existing stream morphology and provide a flushing action are higher than the flow required for fish passage.

Monthly flow recommendations for the low and high flow periods are compared in Table 15 to the median monthly flows of record, as derived from USGS flow records for the gage near the mouth of Pinkham Creek. The flow recommendations would require that all the water during a normal water year be maintained instream from approximately August through March.

The instream flow recommendations, when adjusted to fall within the constraints of water availability for a median or normal water year, equal 7,548 acre-feet of water per year, which is almost 52% of the annual volume of water that is normally available at the USGS gaging site near the mouth of Pinkham Creek.

Table 15. Comparison of the instream flow recommendations for Pinkham Creek to the approximate median flows of record.

	Instream Flow Recommendations[a]	Approximate Median Flows of Record[b]	
	CFS	CFS	AF
January	5.0	1.75	108
February	5.0	1.24	69
March	5.0	4.93	303
April 1-15	5.3	20.6	613
April 16-30	36.3	76.3	2,270
May 1-15	73.5[c]	128.3	3,816
May 16-31	50.2	116.9	3,709
June 1-15	31.0	54.4	1,618
June 16-30	11.0	31.3	931
July	5.0	9.97	613
August	5.0	1.38	85
September	5.0	0.79	47
October	5.0	0.66	41
November	5.0	3.01	179
December	5.0	2.32	143
			14,545[d]

a - Derived using the wetted perimeter/inflection point method and the dominant discharge/channel morphology concept.

b - Derived from flow records for a 9-year period of record (between 1973 and 1981 water years) for the USGS gage on Pinkham Creek, 0.9 miles upstream from Lake Koocanusa.

c - The bankful discharge, which is presently undefined, should be maintained for 24 hours during this period.

d - Approximate volume of water normally available on an annual basis.

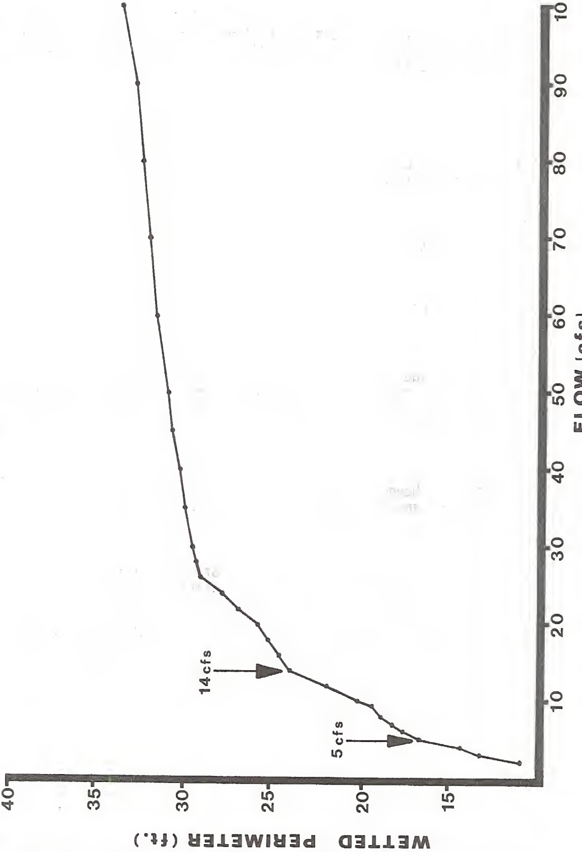

Figure 10. The relationship between wetted perimeter and flow for a composite of five riffle cross-sections in Pinkham Creek.

1. STREAM

Pipe Creek from its confluence with the Kootenai River about 3 miles downstream from Libby, Montana (T31N, R31W, Sec. 30) upstream to the junction of the East Fork (T33N, R31W, Sec. 16).

2. DESCRIPTION

Stream Length

Mouth Pipe Creek to junction of East Fork: 19 miles
Perennial stream in drainage: 54 miles

Drainage Area

Total Pipe Creek: 105.5 sq. mi.

Gradient

Mouth to East Fork: 58.4 ft per mile

Origin and Land Use

Pipe Creek arises on the southwest slopes of the Purcell Mountains and flows south for approximately 22 miles to its confluence with the Kootenai River. About 81% of the drainage is within the Kootenai National Forest. Timber production is the primary land use in the drainage.

Flows

Little flow data have been collected on Pipe Creek, except for sporadic measurements taken by personnel of the Kootenai National Forest.

Water Quality

Pipe Creek has a $B\text{-}D_1$ classification under the State Water Quality Standards. Waters classified $B\text{-}D_1$ are suitable for drinking, culinary, and food processing purposes after adequate treatment equal to coagulation, sedimentation, filtration, disinfection and any additional treatment necessary to remove naturally present impurities, bathing, swimming and recreation, growth and propagation of salmonid fishes and associated life, waterfowl and furbearers; and agricultural and industrial water supply.

Pipe Creek is a fairly productive stream having a total alkalinity of 124 mg/l in the summer and a pH of 8.00.

Recreational Use

The fishing pressure on Pipe Creek during the 1975-76 season was estimated at 2,044 angler days (MDFG 1976). Pipe Creek produces a good rainbow trout fishery, is close to Libby and has good access via a paved road. Hunting is

another popular sport in the drainage. The Pipe Creek drainage supports one of the better moose populations in the area. Other species harvested include elk, white-tailed deer, black bear, mule deer and ruffed, blue and Franklin grouse.

Potential Environmental Problems

Housing developments and the proposed water diversions for these developments are potentially the most serious environmental problems affecting the drainage. Timber harvesting in the drainage could increase sediment loads and peak flows, which would adversely affect channel stability and fish habitat.

3. FISHERIES MANAGEMENT

Pipe Creek has been managed primarily as a spawning and nursery tributary for rainbow trout spawners from the Kootenai River. A survey conducted in 1977 showed that the mainstem Pipe Creek had 12.0 miles of good spawning habitat and 7.1 miles of fair spawning habitat.

The protection of water quality and fish habitat and the maintenance of fish passage have been the management priorities in the Pipe Creek drainage. Several barriers to the upstream movement of spawning rainbow trout have been removed. Timber sales have been reviewed with the Kootenai National Forest to minimize the effects of logging and road building upon the aquatic environment.

4. FISH POPULATIONS

The spawning runs of rainbow trout ascending Pipe Creek from the Kootenai River were sampled in 1976, 1977 and 1981. Only a part of the run was captured each year, due to high flows which limited the trapping operation to only a portion of the spawning period. The number of rainbow trout spawners migrating into Pipe Creek appears to have increased from 1976-1981 (Table 16). The average catch per day of trap operation was 3.9 fish in 1981 as compared to 1.7 in 1977 and 3.0 in 1976. The total run of rainbow trout into Pipe Creek is probably in the range of 300-500 fish, which makes Pipe Creek one of the most important spawning and nursery tributaries for rainbow trout from the Kootenai River.

The average size of the males and females in the run has declined markedly from 1976-81. This decline is due to the reduced growth rates of rainbow trout in the Kootenai River (May et al. 1981).

The fish densities in Pipe Creek were determined in 1981 using the underwater census technique. A total of four class one pools having an area of 5,627 square feet were snorkeled during the survey. A total of 184 rainbow trout ranging in size from 3.0-11.0 inches in total length were observed (Table 17). Numerous young-of-the-year rainbow trout, sculpins and one brook trout were also noted. The density of 3.27 rainbow trout per 100 sq. ft. of pool surface area indicates that the trout population in Pipe Creek is well above average when compared to other streams in the area.

Table 16. Summary of data for rainbow trout spawning runs into Pipe Creek from the Kootenai River in 1876, 1977 and 1981.

Time Interval Trap in Operation	Days Trap in Operation	No. of Spawners	Average Catch per Day of Trap Operation	Average Length in Inches Male	Average Length in Inches Female
3/18-4/5/76	18	54	3.0	14.2	18.3
3/3-5/20/77	46	78	1.7	14.1	17.4
3/17-4/20/81	22	85	3.9	11.3	13.2

Table 17. Number of rainbow trout observed in August 1981 during an underwater fish census in four class one pools in Pipe Creek (T31N, R31W, Sec. 20).

Length Group in Inches	Approximate Age	Total Number Counted	No./100 Sq. Ft. of Pool Surface
3.0 - 6.9	1 & 2	159	2.82
7.0 -11.0	3 & 4	25	0.44
Total		184	3.26

5. FLOW RECOMMENDATIONS

Cross-sectional measurements were made in a series of five riffle areas of Pipe Creek, approximately 1 mile upstream from its confluence with the Kootenai River (T31N, R31W, Sec. 20). The WETP program was calibrated to field data collected at flows of 14.4, 26.8 and 392.2 cfs. The lower and upper inflection points on the wetted perimeter-discharge relationship occur at flows of about 12 and 25 cfs, respectively (Figure 11). Based on an evaluation of existing fishery, recreational use, water availability and other resource information, a flow of 15 cfs is recommended for the low flow period from July 1 through March 31.

The flow required to ensure fish passage for the spring spawning run of rainbow trout is approximately 25 cfs (Table 18). The average depth for all five riffle cross sections at this flow exceeds 0.5 ft, the approximate minimum depth required for successful trout passage. A passage flow of 25 cfs should be maintained from April 1 through June 30.

Table 18. The average depth for five riffle cross-sections in Pipe Creek at selected flows of interest.

	Average Depth (ft)				
Flow (cfs)	Riffle #1	Riffle #2	Riffle #3	Riffle #4	Riffle #5
16	.67	.43	.46	.67	.40
20	.66	.54	.52	.70	.47
25	.65	.65	.57	.78	.55

Due to the lack of long-term flow data, recommendations based on the dominant discharge/channel morphology concept cannot be derived for Pipe Creek.

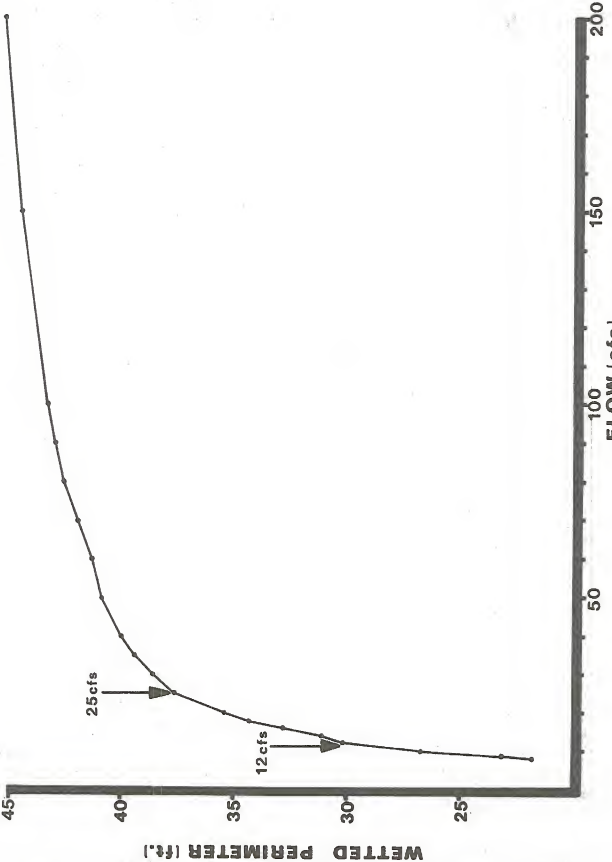

Figure 11. Relationship between wetted perimeter and flow for a composite of five riffle cross sections in Pipe Creek.

1. STREAM

Rock Creek from its mouth near Noxon, Montana (T26N, R32W, Sec. 32) upstream to Rock Creek Meadows (T26N, R31W, Sec. 6).

2. DESCRIPTION

Stream Length

Mouth of Rock Creek to Rock Creek Meadows: 10 miles

Drainage Area

Total Rock Creek: 31.9 square miles

Gradient

Mouth to Rock Creek Meadows: 128 ft per mile

Origin and Land Use

Rock Creek arises on the west slopes of the Cabinet Mountains and flows in a southwesterly direction to its confluence with the Clark Fork River about 2 miles upstream from Noxon. The upper part of the drainage is located in the Cabinet Mountains Wilderness Area. Approximately 94% of the drainage is in the Kootenai National Forest, with the remainder in private ownership. Timber production is the primary land use in the drainage.

Flows

Little flow data have been collected on Rock Creek, except for sporadic measurements taken by personnel of the Kootenai National Forest. Flows in the lower 1-2 miles of Rock Creek go underground during the late summer and fall in most years.

Recreational Usage

A fishing pressure survey conducted in 1975 showed an estimated 438 mandays of angling on Rock Creek (MDFG 1976). The westslope cutthroat trout is the primary species creeled.

Hunting is a popular recreational activity in the drainage. Game species harvested include white-tailed deer, mule deer, elk, ruffed and blue grouse, black bear and mountain goat.

Hiking and mountain climbing are popular activities in the portion of the drainage in the Cabinet Mountains Wilderness Area.

Potential Environmental Problems

Nearly all of the drainage is in the Kootenai National Forest. Exploratory work conducted by mining companies has indicated that deposits of copper and silver may be of sufficient size to mine profitably. Development of mines could

increase sediment loads, and pollute the water with heavy metals. In addition, water will probably be diverted from Rock Creek for use in milling and concentrating operations.

Water Quality

Rock Creek has a B-D$_1$ classification under the State Water Quality Standards. Waters classified B-D$_1$ are suitable for drinking, culinary and food processing purposes after adequate treatment necessary to remove naturally present impurities; bathing, swimming and recreation; growth and propagation of salmonid fishes and associated aquatic life, waterfowl and furbearers; and agricultural and industrial water supply.

The limited water quality information that has been collected indicates that Rock Creek is a softwater stream with low buffering capacity. The total alkalinity has ranged between 10-51 mg/l, and averages 37 mg/l during the low flow period in the summer. The pH varies between 6.6-7.8 and averages 7.3

3. FISHERIES MANAGEMENT

The fisheries management program in the drainage has been concerned primarily with habitat and water quality protection. Timber sales have been reviewed with the Kootenai National Forest and recommendations submitted to minimize the effects of logging and associated road building on the aquatic environment.

4. FISH POPULATIONS

Fish populations were sampled in Rock Creek in September 1979 using electrofishing gear and again in August 1981 using the snorkeling technique. The electrofishing (Table 19) and snorkeling (Table 20) estimates indicate that Rock Creek supports a good population of cutthroat and brook trout. The electrofishing estimate for all water types was 2.16 trout per 100 square feet of surface area as compared to 2.90 trout per 100 square feet of pool surface area for the snorkel count. The data indicate that Rock Creek supports a dense trout population for an infertile stream.

The cutthroat trout was the dominant species, composing 77 percent and 67 percent of the electrofishing and snorkeling estimates, respectively. The cutthroat appears to be a pure native strain of westslope cutthroat. The growth of these fish was good, and several fish over 12.0 inches were noted during the underwater survey.

The westslope cutthroat, a species of special concern in Montana, is found in the more pristine drainages, which have been relatively undisturbed by man's activities. The success of the westslope cutthroat trout is related to maintenance of environmental quality. Any habitat disruption resulting in increased siltation, warmer water temperatures, and dewatering makes the native cutthroat trout vulnerable to replacement by nonnative fishes (Behnke 1974). The native cutthroat trout has been eliminated from much of its original range in the interior waters of North America. Protection of existing stocks is important if the genetic diversity of this species is to be maintained.

Table 19. Population estimates by length groups and approximate age classes for trout in Rock Creek, (T26N, R32W, Sec. 27), September 1979. The 80% confidence limits are given in parentheses as a percent of the point estimate.

Length Group	Assigned Age	% Age Composition	Ave. Length (Inches)	Ave. Weight (Pounds)	Per 100 Square Feet of Surface Area: Number	Per 100 Square Feet of Surface Area: Weight
Cutthroat Trout						
3.0 - 4.9	1	37.3	4.0	.03	.53	-
5.0 - 6.9	2	29.1	6.2	.10	.42	-
7.0 -11.4	3 & 4	33.6	8.9	.27	.49	-
					1.44(±30.5%)	.19
Brook Trout						
4.3 - 6.9	1 & 2	85.3	5.4	.06	.61	-
7.0 - 8.5	2 & 3	14.7	7.5	.17	.11	-
					.72(±34.8%)	.05
Total					2.16	.24

Table 20. Number of cutthroat trout and brook trout observed in August 1981 during an underwater fish census in four class one pools in Rock Creek (T26N, R32W, Sec. 27).

Length Group (Inches)	Assigned Age	Total No. Counted	No./100 sq. ft. of Pool Surface Area
		Cutthroat Trout	
3.0 - 6.9	1 & 2	101	1.60
7.0 -15.0	3 - 5	50	.80
		151	2.40
		Brook Trout	
3.0 - 6.9	1 & 2	25	.40
7.0 -12.0	3 & 4	6	.10
		31	.50
Total		132	2.90

4. FLOW RECOMMENDATIONS

Cross-sectional measurements were made in a series of five riffle areas of Rock Creek, approximately 2 miles upstream from its confluence with the Clark Fork River (T26N, R32W, Sec. 27). The WETP program was calibrated to field data collected at flows of 4.9, 22.2 and 264.3 cfs. The lower and upper inflection points on the wetted perimeter-discharge relationship occur at flows of about 9 and 30 cfs, respectively (Figure 12). Based on an evaluation of existing fishery, recreational use, water availability and other resource information, a flow of 10 cfs is recommended for the low flow period from July 1 through March 31.

Due to the lack of long-term flow data, recommendations based on the dominant discharge/channel morphology concept cannot be derived for Rock Creek.

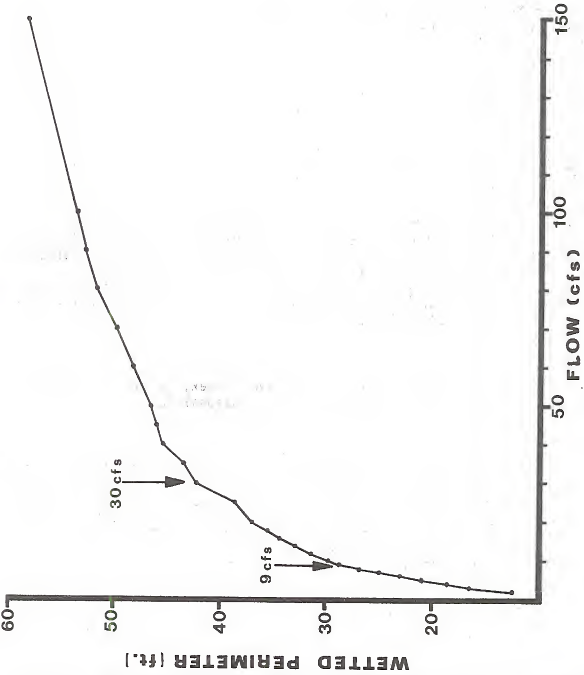

Figure 12. Relationship between wetted perimeter and flow for a composite of five riffle cross-sections in Rock Creek.

1. STREAM

Ross Creek from its confluence with Bull Lake (T28N, R33W, Sec.4) upstream to the junction of the South Fork of Ross Creek (T28N, R34W, Sec. 15)

2. DESCRIPTION

Stream Length

Mouth of Ross Creek to South Fork: 8 miles
Perennial stream in drainage: 14 miles

Drainage Area

Total Ross Creek - 25.0 square miles

Gradient

Mouth to South Fork: 59.5 ft per mile

Origin and Land Use

Ross Creek arises on the east slopes of the West Cabinet Mountains and flows east about 10 miles to its confluence with Bull Lake. The entire drainage, except for approximately one section of land, is within the Kootenai National Forest. The upper part of the drainage is in the proposed Scotchman Peak Wilderness Area. The drainage is roadless except for about 4 miles of road between the stream's mouth and the Ross Creek Cedars Recreation Area. Recreation is the primary land use within the drainage.

Flows

Little flow data have been collected for Ross Creek, except for sporadic measurements taken by personnel of the Kootenai National Forest.

Water Quality

Ross Creek has a $B\text{-}D_1$ classification under the State Water Quality Standards. Waters classified $B\text{-}D_1$ are suitable for drinking, culinary and food processing purposes after adequate treatment equal to coagulation, sedimentation, filtration, disinfection and any additional treatment necessary to remove naturally present impurities; bathing, swimming and recreation, growth and propagation of salmonid fishes and associated life, waterfowl and furbearers; and agricultural and industrial water supply.

Ross Creek is an infertile coldwater stream with low buffering capabilities. The total alkalinity ranges from 19-32 mg/l and the pH averages about 7.3. The maximum water temperature during the summer is approximately 50° F.

Recreational Usage

An estimate of 174 mandays of angling use on Ross Creek was generated by a fishing pressure survey in 1975 (MDFG 1976). Ross Creek offers a unique fishery for westslope cutthroat trout in an unspoiled environment.

The Ross Creek drainage supports an excellent elk herd and elk hunting is a major activity during the fall in the upper drainage. Other species hunted include mule deer, white-tailed deer, black bear and mountain grouse.

The Ross Creek Cedars Natural Area is a designated recreational site in the Kootenai National Forest featuring cedar trees up to 400 years old. The "Cedars" is a popular recreational area having approximately 14,000 visitors annually.

Potential Environmental Problems

Exploratory work by the American Smelting and Refining Company has indicated that a large ore body of copper and silver exists near Ross Point. The probability that the deposit will be developed in the near future is quite good. Development of the ore body could degrade the water quality of Ross Creek and require water withdrawals for the mining and concentrating operations.

3. FISHERIES MANAGEMENT

Fisheries management activities in the Ross Creek drainage have been limited due to the remoteness and pristine condition of the drainage.

4. FISH POPULATIONS

Comparatively little fish data have been collected on Ross Creek due to its remote location and poor access. The results of an underwater fish survey conducted in class one pools in August 1981 are shown in Table 21. Cutthroat trout was the only species of fish observed. Approximately 0.99 cutthroat per 100 sq. ft. of pool surface area were counted in the five pools. The density of trout is low when compared to the more productive streams, but is about average for an infertile headwaters stream. The fish observed represent a minimum estimate of the number of fish in the pools.

Table 21. The number of cutthroat trout observed in August, 1981 during an underwater fish census in five class one pools in Ross Creek (T28N, R34W, Sec. 7).

Length Group In Inches	Approximate Age	Total Number Counted	Number Per 100 sq ft of Pool Surface Area
3.0-6.9	1 & 2	53	0.83
7.0-9.0	3 & 4	10	0.16
		63	0.99

The cutthroat trout in Ross Creek appear to be a pure native strain of westslope cutthroat. The westslope cutthroat trout, a species of special concern in Montana, is found in the more pristine drainages which have been relatively undisturbed by man's activities. The success of the westslope cutthroat is related to maintenance of environmental quality. Any habitat disruption resulting in increased siltation, warmer temperatures and dewatering makes the native cutthroat trout vulnerable to replacement by nonnative fishes (Behnke 1974). The native cutthroat trout has been eliminated from much of its original range in the interior waters of North America. The protection of existing stock is essential if the genetic diversity of this vanishing species is to be maintained.

4. FLOW RECOMMENDATIONS

Cross-sectional measurements were made in a series of five riffle areas of Ross Creek, approximately 3 miles upstream from its confluence with Bull Lake (T28N, R34W, Sec. 7). The WETP program was calibrated to field data collected at flows of 10.0, 21.1 and 270.7 cfs. The lower and upper inflection points on the wetted perimeter-discharge relationship occur at flows of about 10 and 16 cfs, respectively (Figure 13). Based on an evaluation of existing fishery, recreational use, water availability and other resource information, a flow of 16 cfs is recommended for the low flow period from July 1 through March 31.

Due to the lack of long-term flow data, recommendations based on the dominant discharge/channel morphology concept cannot be derived for Ross Creek.

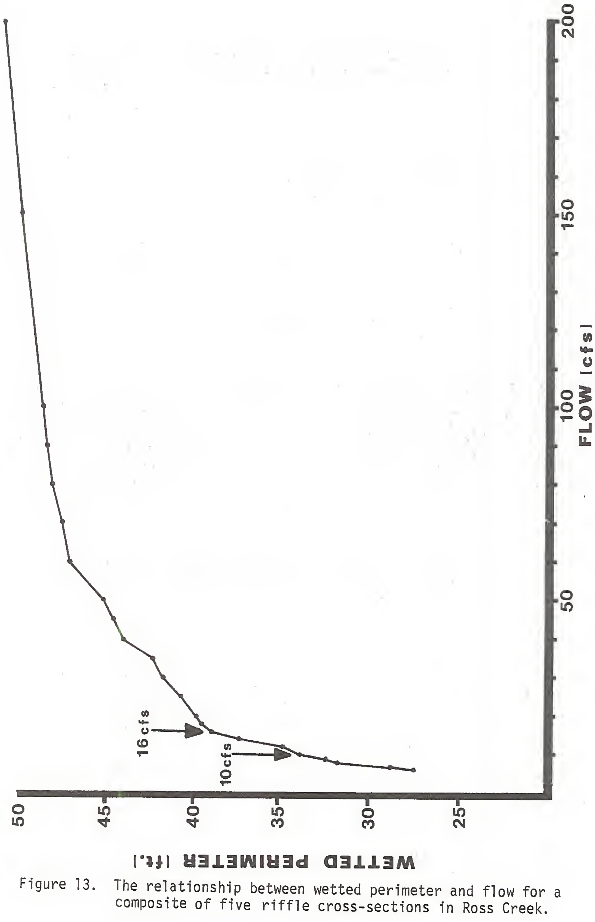

Figure 13. The relationship between wetted perimeter and flow for a composite of five riffle cross-sections in Ross Creek.

1. RIVER

Tobacco River from its mouth near Rexford, Montana (T36N, R27W, Sec. 8) upstream to the confluence of Fortine and Graves creeks (T35N, R26W, Sec. 15).

2. DESCRIPTION

Stream Length

Length of mainstem Tobacco: 10 miles
Length of perennial streams in drainage: 266 miles

Drainage Area

Total Tobacco River: 440 square miles

Gradient

Mouth to confluence of Fortine and Graves creeks: 32.7 ft/mile

Origin and Land Use

The Tobacco River has its origin at the confluence of its two major tributaries, Graves and Fortine creeks. Graves Creek arises on the west side of the Whitefish Range and flows south for about 16 miles. Fortine Creek arises on the east slopes of the Salish Mountains and flows north for approximately 27 miles to its confluence with Graves Creek. Approximately 70 percent of the drainage is in the Kootenai National Forest, with the remainder in private ownership. Timber production is the primary land use in the drainage, but there is also a considerable amount of land in pasture and forage production.

Flows

Since 1958, the USGS has operated a flow gage 2.8 miles upstream from the mouth of the Tobacco River. During this period, the discharge averaged 270 cfs and ranged from 20 to 2,470 cfs.

Recreational Usage

A fishing pressure survey conducted in 1975 showed an estimated 1,276 man-days of angling on the Tobacco River (MDFG 1976). The pressure has increased considerably since 1975 as a result of increased spawning runs of rainbow and cutthroat trout from Lake Koocanusa. A popular fishery for resident rainbow, cutthroat and brook trout exists during summer and fall.

The drainage provides good hunting for moose, elk, white-tailed deer, mule deer, black bear, grizzly bear and mountain grouse. The Ten Lakes Scenic Area provides high quality backcountry recreation.

Potential Environmental Problems

A major threat to the aquatic resources of the Tobacco River drainage is from dewatering due to agricultural practices and subdivision developments.

The Kootenai National Forest has received applications for micro hydro projects on Deep Creek, Blue Sky Creek, Williams Creek, Clarence Creek and Stahl Creek. These projects would dewater appriximately 21.6 miles of stream in the Tobacco River drainage.

Sediment pollution from logging and associated road building and agricultural practices will continue to be a problem in the future. The sediment problem is most severe in Fortine Creek.

Water Quality

The Tobacco River drainage, except for Deep Creek, has a $B\text{-}D_1$ classification under the State Water Quality Standards. Waters classified $B\text{-}D_1$ are suitable for drinking, culinary and food processing purposes after adequate treatment equal to coagulation, sedimentation, filtration, disinfection and any additional treatment necessary to remove naturally present impurities; bathing, swimming and recreation; growth and propagation of salmonid fishes and associated aquatic life, waterfowl and furbearers; and agricultural and industrial water supply. Deep Creek, the water supply for Fortine, is classified $A\text{-Open-}D_1$.

The Tobacco River is a moderately productive stream with an average pH of 8.3 and total alkalinity of 128 mg/l in the late summer. Water temperatures during the summer of 1980 averaged 13.7C and ranged from 5.0-22.0C.

3. FISHERIES MANAGEMENT

The Tobacco River drainage has been managed to mitigate fishery losses caused by the construction of Libby Dam. The program began in 1973 and was concerned primarily with the enhancement of spawning runs of cutthroat trout from Lake Koocanusa. Rainbow trout, bull trout, and mountain whitefish spawning runs also benefited from the development program.

The development work involved the removal of natural barriers to migratory trout in Clarence, Stahl, Blue Sky, Graves, Fortine, Deep and Therriault creeks. Resident fish populations were chemically suppressed in Clarence Creek. Imprint plants of sub-fingerling westslope cutthroat trout were made in Blue Sky, Clarence, Deep, Fortine, Graves and Sinclair creeks. A total of 586,800 sub-fingerlings was planted from 1972 through 1980.

Considerable time and effort were spent in providing fish passage at an irrigation diversion dam on Graves Creek and a water supply dam on Sinclair Creek. These projects provided access into about 25 miles of quality spawning habitat.

The cost of the Tobacco River fishery development was approximately $50,930. The cost has been shared by five government agencies and one sportsmen's group. These were the MDFWP, Corps of Engineers, Soil Conservation Service, Kootenai National Forest, Lincoln County Conservation District and the Tobacco Valley Rod and Gun Club.

4. FISH POPULATIONS

The results of a trout spawning survey conducted in the Tobacco River drainage in 1979 are summarized in Table 22 (from May and Huston 1980). Mark and recapture data were used to estimate the magnitude of the runs. The point estimates for the rainbow and cutthroat runs were 5,937 and 516 fish, respectively. The confidence limits for the estimates were large, indicating that the actual number of fish could vary considerably from the point estimates. The rainbow estimates appear to be high, while the cutthroat estimate is probably low. The data indicate that the Tobacco River drainage supports substantial spawning runs of cutthroat and rainbow trout.

The fish in the run were good sized, with rainbow females averaging 16.3 inches in total length as compared to 15.2 inches for female cutthroat. The total fecundity (egg potential) of the runs was estimated at 281,000 and 3,233,000 cutthroat and rainbow trout eggs, respectively.

Table 22. Summary of data from rainbow and cutthroat trout runs ascending the Tobacco River drainage, April-July 1979. The 80% confidence limit for the point estimate is given in parentheses.

Parameter	Species	
	Cutthroat	Rainbow
Point estimate	516 (+35%)	5,937 (+40%)
Sex ratio male:female	1.00:1.20	1.00:1.20
Average length male in inches	14.5	16.0
Average weight male in pounds	1.21	15.4
Average length female in inches	15.2	16.3
Average weight female in pounds	1.24	1.58
Fecundity	281,000	3,233,000

In addition to the cutthroat and rainbow runs, the Tobacco River supports fall spawning runs of mountain whitefish and bull trout. These runs have not been quantified, but surveys have indicated the whitefish run is probably in the 10,000-30,000 range, whereas the bull trout run consists of several hundred fish. Overall, the Tobacco River is the most important spawning and rearing drainage in the Montana portion of the Lake Koocanusa system.

5. FLOW RECOMMENDATIONS

Cross sectional measurements were made in a series of five riffle areas of the Tobacco River approximately 1 mile upstream from the mouth of Therriault Creek (T35N, R26W, Sec. 4). The WETP program was calibrated to field data collected at flows of 106, 146 and 746 cfs. The inflection point on the wetted perimeter-discharge relationship occurs at a flow of about 100 cfs (Figure 14). A flow of 100 cfs is being recommended for the low flow period from July 16-April 15.

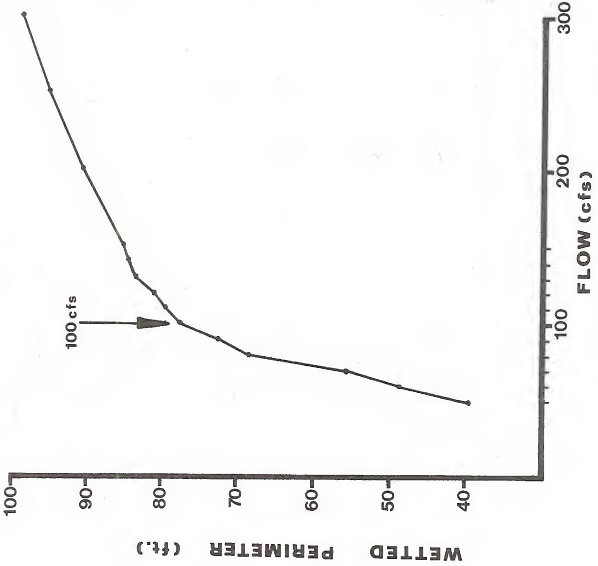

Figure 14. The relationship between wetted perimeter and flow for a composite of five riffle cross sections in the Tobacco River.

The flow required to insure fish passage for spawning trout is 120 cfs (Table 23). The average depth for all five riffles at this flow exceeds 0.5 ft, the approximate minimum depth required for successful trout passage.

During the high flow period of April 16-July 15, a flow of at least 120 cfs is needed to successfully pass migrating trout to their upstream spawning areas. However, the high flows that are needed to maintain the existing stream morphology and provide a flushing action, as derived from the dominant discharge/channel morphology concept, exceed 120 cfs. Consequently, the dominant discharge/channel morphology concept is used in deriving the high flow recommendations.

Table 23. The average depth (ft) for five riffle cross sections in the Tobacco River at selected flows of interest.

	Average Depth (ft.)				
Flow (cfs)	Riffle #1	Riffle #2	Riffle #3	Riffle #4	Riffle #5
100	.44	.65	.79	.68	.47
110	.49	.69	.85	.72	.52
120	.54	.73	.91	.75	.57

Monthly flow recommendations for the low and high flow periods are compared to the median monthly flows of record, as derived from USGS flow records for the gage near the mouth of the Tobacco River, in Table 24. The flow recommendations would require that all of the flow during a normal water year be maintained instream for fishery purposes from approximately September through March.

The recommendations, when adjusted to fall within the constraints of water availability for a median or normal water year, equal 136,241 acre-feet of water per year, which is about 73% of the annual volume of water that is normally available at the USGS gaging site near the mouth of the Tobacco River.

Table 24. Comparison of the instream flow recommendations for the Tobacco River to the approximate median flows of record.

Time Period	Flow Recommendations[a/] cfs	Median Flows[b/] cfs	Median Flows[b/] Acre-ft
January	100	95	5,840
February	100	96	5,330
March	100	115	7,069
April 1-15	100	228	6,782
April 16-30	171	355	10,559
May 1-15	409	696	20,703
May 16-31	692	916	29,063
June 1-15	703[c/]	908	27,008
June 16-30	433	666	19,810
July 1-15	282	450	13,385
July 16-31	100	231	7,329
August	100	128	7,869
September	100	104	6,187
October	100	102	6,270
November	100	104	6,187
December	100	99	6,086
Total			185,477

a - Derived from the dominant discharge/channel morphology concept, the wetted perimeter/inflection point method and the trout passage requirement.

b - Derived for a 9-year period of record (between 1965 and 1973 water years) for the USGS gage near Eureka (2.8 miles upstream from mouth).

c - A flow of 1,263 cfs (the approximate bankful discharge) should be maintained for 24 hours during this period.

1. RIVER

Yaak River from its mouth 8 miles west of Troy, Montana (T32N, R34W, Sec. 5) upstream to the Yaak Falls (T33N, R33W, Sec. 4).

2. DESCRIPTION

Stream Length

Mouth of Yaak to Yaak Falls:	9 miles
Yaak Falls to confluence of North & East Forks:	41 miles
Length of perennial streams in drainage in Montana:	393 miles

Drainage Area

Total Yaak River: 766 square miles

Gradient

Mouth to Yaak Falls: 71.1 ft/mile
Falls to confluence North & East Forks: 15.0 ft/mile

Origin and Land Use

The North Fork of the Yaak River arises on the west slopes of the Purcell Mountains in British Columbia, approximately 5 miles north of the BC-Montana border. The East and West Forks of the Yaak originate in Montana. The mainstem Yaak flows in a westerly direction to its confluence with the Kootenai River. Approximately 97 percent of the drainage is in the Kootenai National Forest, with the remainder in private ownership. Timber production is the primary land use in the drainage.

Flows

The USGS has continuously operated a flow gage 0.2 miles upstream from the mouth of the Yaak River since March 1956. During the 24 years of gage operations, the discharge averaged 889 cfs, whereas the minimum and maximum discharges have been 50 and 12,100 cfs, respectively.

Recreational Use

A fishing pressure survey conducted in 1975 showed an estimated 3,842 mandays of fishing pressure on the mainstem Yaak (MDFG 1976). The Yaak has a reputation of being one of the best fishing streams in Lincoln County. Little development has occurred along the mainstem and much of the river is in a pristine condition with high aesthetic and fishery values. The Yaak River from the falls to the Kootenai flows through a scenic canyon which is essentially a wild river with no development or road access.

Angler log data compiled by the MDFWP showed the catch consisted of rainbow trout (90.5%), cutthroat trout (6.5%) and brook trout (3.0%). The catch rate for all trout combined was 2.6 fish per hour of effort, indicating that the Yaak provides an excellent fishery. The rainbow and cutthroat averaged 7.9 inches in total length, as compared to 6.9 inches for brook trout.

Potential Environmental Problems

Four potential dam sites are located on the Yaak River. These sites have been withdrawn by the Kootenai National Forest for power development. At the present time, there is no agency actively trying to develop these sites. The two dam sites most likely to be developed are located at the Yaak Falls (river mile 9.2) and near Long Meadows (river mile 30.8).

The subdivision of old homesteads along the river could lower water quality and reduce aesthetic values. Considerable subdivision has already occurred in the Vinal Lake area.

An increased rate of logging is planned for the Yaak drainage to remove lodgepole pine damaged by the mountain pine beetle. Logging activities and associated road building will increase sediment loads significantly, unless strict erosion control guidelines are enforced during the salvage operation.

Water Quality

The Yaak River drainage has a $B\text{-}D_1$ classification under the State Water Quality Standards. Waters classified $B\text{-}D_1$ are suitable for drinking, culinary and food processing after adequate treatment equal to coagulation, sedimentation, filtration, disinfection and any additional treatment necessary to remove naturally present impurities; bathing, swimming, and recreation; growth and propagation of salmonid fishes and associated aquatic life, waterfowl and furbearers; and agricultural and industrial water supply.

The Yaak is a low-to-moderately productive river having an average total alkalinity of 67 mg/l and an average pH of 8.0.

3. FISHERIES MANAGEMENT

The fisheries program in the Yaak has been primarily concerned with water quality and habitat protection. The vast majority of the Yaak is in the Kootenai National Forest and the DFWP has worked closely with the Yaak Ranger District to minimize the effects of logging and associated road building upon the aquatic resource.

The DFWP and the Kootenai National Forest have discussed the possibility of constructing a spawning channel for rainbow trout downstream from the Yaak Falls.

4. FISH POPULATIONS

Comparatively little fisheries data have been collected on the Yaak River due to its remote location. Electrofishing has been attempted, but with

little success. Much of the Yaak is deeper than four to six feet, which limits the effectiveness of the electrofishing gear. In addition, the standard conductivities of about 119 micromhos/cm are too low for sampling efficiently with electrofishing gear.

A fish trap was operated near the mouth of the Yaak from September 29 to November 4, 1971 (May and Huston 1973). A total of 53 mountain whitefish, which ranged in total length from 8.1 to 15.4 inches, were collected. In addition, eleven kokanee salmon were taken and these fish ranged in total length from 9.1-16.2 inches. The kokanee are thought to originate from the Kootenay Lakes in British Columbia about 102 miles downstream from the mouth of the Yaak.

The Yaak, below the falls, also supports a spring spawning run of rainbow trout in the 5-10 pound class, which is thought to originate from the Kootenay Lakes. This run, however, has not been sampled other than by anglers.

The results of an underwater fish survey conducted in the Yaak River about six miles downstream from the falls is shown in Table 25. A total of 23 rainbow trout ranging from 3.0-16.0 inches in total length and 6 mountain whitefish in the 14.0-18.0 length range were counted during the underwater fish census. The two pools censured had a total area of 11,193 sq ft. The number of fish counted represents a minimum estimate of the total fish in the pool. The number of rainbow observed amounted to only .20 fish per 100 sq ft of pool. Three of the rainbow were larger than 14.0 in total length.

Table 25. The number of rainbow trout and mountain whitefish observed in August, 1981 during an underwater fish census in two class one pools in the lower Yaak River (T33N, R33W, Sec. 30).

Length Group in Inches	Assigned Age	Total Number Counted	Number Per 100 sq ft of Pool Surface Area
	Rainbow Trout		
3.0 - 6.9	1 & 2	16	0.14
7.0 - 16.0	3 - 5	7	0.06
		23	0.20
	Mountain Whitefish		
14.0 - 18.0	4 - 7	6	.05

Other species observed included mountain whitefish, largescale suckers, northern squawfish and torrent sculpins.

4. FLOW RECOMMENDATIONS

Cross-sectional measurements were made in a series of five riffle areas in the Yaak River approximately five miles upstream from its mouth (T33N, R33W, Sec. 30). The WETP program was calibrated to field data collected at flows of 225,235 and 970 cfs. The inflection point on the wetted perimeter-discharge relationship occurs at a flow of about 200 cfs (see Figure 15). A flow of 200 cfs is, therefore, being recommended for the low flow period from July 16 to March 31.

During the high flow period of April 1 - July 15, a flow of at least 200 cfs is needed to successfully pass migrating trout to their upstream spawning areas. However, the high flows that are needed to maintain the existing stream morphology and provide a flushing action, as derived from the dominant discharge/channel morphology concept, exceed 200 cfs. Consequently, the dominant discharge/channel morphology concept was used in deriving the high flow recommendations.

Monthly flow recommendations for low and high flow periods are compared to the median monthly flows of record, as derived from USGS flow records for the gage near the mouth of the Yaak River, in Table 26. The flow recommendations would require that all the water during a normal water year be maintained instream for fishery purposes from approximately August 1 through October 30.

The flow recommendations, when adjusted to fall within the constraints of water availability for a median or normal water year, equal 420,495 acre feet of water per year. This equals approximately 72 percent of the annual volume of water that is normally available at the USGS gaging station near the mouth of the Yaak River.

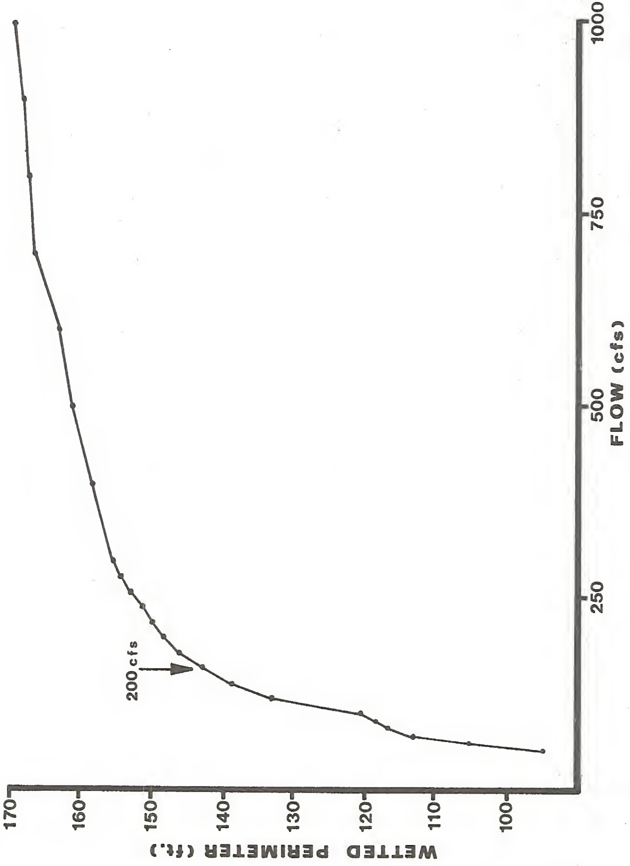

Figure 15. The relationship between wetted perimeter and flow for a composite of five riffle cross-sections in the lower Yaak River.

Table 26. Comparison of the instream flow recommendations for the Yaak River to the approximate median flows of record.

Flow Recommendations a/		Median Flows b/	
Time Period	cfs	cfs	Acre-Feet
January	200	233	14,323
February	200	319	17,712
March	200	404	24,835
April 1-15	726	1,006	29,923
April 16-30	902	1,375	40,899
May 1-15	2,063	3,372	100,300
May 16-31	3,221 c/	4,302	136,494
June 1-15	2,152	2,914	86,677
June 16-30	894	1,410	41,940
July 1-15	414	707	21,030
July 16-31	200	343	10,883
August	200	196	12,049
September	200	164	9,756
October	200	183	11,250
November	200	231	13,742
December	200	219	13,463
			585,276

a/ Derived from the dominant discharge/channel morphology concept, the wetted perimeter/inflection point method and the trout passage requirement.

b/ Derived for a nine-year period of record (between 1965 and 1973 water years) for the USGS gage located 0.2 miles upstream from the mouth of the Yaak River.

c/ A flow of 6,400 cfs (the approximate bankful discharge) should be maintained for 24 hours during this period.

1. STREAM

Young Creek from its mouth near Rexford, Montana (T37N, R28W, Sec. 24) upstream to the confluence of the South Fork (T37N, R29W, Sec. 14).

2. DESCRIPTION

Stream Length

Length of Young Creek: 11 miles
Length of perennial stream in drainage: 14 miles

Drainage Area

Total Young Creek: 46.6 square miles

Gradient

Mouth to confluence with South Fork: 125 ft per mile

Origin and Land Use

Young Creek originates on the east slopes of the Purcell Mountains of northwestern Montana and flows in a westerly direction to its confluence with Lake Koocanusa three miles south of the Montana-British Columbia border. Approximately 87 percent of the drainage is in the Kootenai National Forest with the remainder in private (11 percent) and state (2 percent) ownership. Timber production is the primary land use, but there is also intensive agricultural use of the meadow areas along the lower two miles of Young Creek.

Flows

The USGS operated a gage near the mouth of Young Creek from March, 1973 through November, 1975. During this period, flows ranged from a low of 3.0 cfs in January, 1974 to a high of 150 cfs in June, 1974. The mean annual flow for the 1974 water year, the only complete year of record, was 25.9 cfs. The gage was located below an irrigation diversion of about one cfs.

Recreational Usage

Approximately 150 man-days of angling were estimated for Young Creek during a fishing pressure survey conducted in 1975 (MDFG 1976). The pressure has increased considerably since then due to a large population increase in the Young Creek area.

Hunting is an important recreational pursuit in the drainage. Species harvested include moose, elk, mule deer, white-tailed deer, black bear and mountain grouse.

Potential Environmental Problems

The major threat to the aquatic resources of Young Creek is from intensified agricultural development and associated irrigation withdrawals. An

Amish community settled along Young Creek in 1978 and now numbers over 100 people. The demand for irrigation water now exceeds the low flow of Young Creek in the late summer and fall.

The Kootenai National Forest is planning to construct new roads in the Young Creek drainage. Additional road building and logging could increase sediment loads, unless strict erosion control guidelines are written into the contracts.

Water Quality

Young Creek has a $B\text{-}D_1$ classification under the State Water Quality Standards. Waters classified $B\text{-}D_1$ are suitable for drinking, culinary and food processing purposes after adequate treatment equal to coagulation, sedimentation, filtration, disinfection, and any additional treatment necessary to remove naturally present impurities; bathing, swimming and recreation, growth and propagation of salmonid fishes and associated aquatic life, waterfowl and furbearers.

Young Creek is a moderately productive stream with a total alkalinity of 130 mg/l in the summer and a standard conductivity of 200 micromhos per cm. Water temperatures ranged from 32° to 65° F in 1970-1976. Like most good westslope cutthroat trout streams, maximum temperatures seldom exceed 60° F.

3. FISHERIES MANAGEMENT

Young Creek has been developed as a spawning and nursery tributary for westslope cutthroat trout from Lake Koocanusa to partially mitigate fishery losses caused by the construction of Libby Dam. The development of Young Creek began in 1969 when the Corps of Engineers constructed an upstream-downstream trap/barrier dam. Personnel of the MDFWP, working under contract to the Corps of Engineers, installed needed fish traps, fish holding facilities and fish screens in early spring, 1970.

Additional development work occurred in 1970, when barriers to upstream fish migration were removed or altered, resident fish stocks were chemically reduced, and imprint plants of sub-fingerling westslope cutthroat trout began. A total of 291,768 sub-fingerlings were planted from 1970-1975. The strain of westslope cutthroat trout living in Hungry Horse Reservoir was used for the imprint plants.

The development work on Young Creek and fish evaluation studies cost approximately $233,436. Nearly all the funds were provided by the Corps of Engineers.

4. FISH POPULATIONS

The upstream trap was operated annually from 1970 to 1980, with the exception of 1978. The downstream trap was fished from 1970-1975, then again in 1980. The upstream trap was used to determine the magnitude of the spawning run, whereas data on smolt production was collected from the downstream trap. The catch of cutthroat trout entering Young Creek to spawn and annual smolt production are listed by year in Table 27 (May & Huston 1975, 1979 & 1980).

Table 27. Number of cutthroat trout spawners and smolts caught in Young Creek traps.

Year	Number of Smolts	Estimated Total Smolts	Number of Spawners
1970			21
1971			54
1972	352	500-1,000	78
1973	1,408	2,000-3,000	102
1974	1,558	3,000-4,000	306
1975	1,341	2,000-3,000	303
1976			692
1977			679
1978			Trap not operated
1979			315
1980	1,849	3,500-4,500	367

The first imprint plants of westslope cutthroat trout were made in Young Creek in 1970 and the Kootenai River was impounded in March, 1972. The fish caught from 1970-1972 were native cutthroat trout from the Kootenai River, while the fish caught from 1973-1980 were both native and hatchery fish. Fish from the imprint plants comprised most of the run from 1974-1980.

Trap catches increased markedly from 102 spawners in 1973 to 692 fish in 1976, then declined to 367 fish in 1980. The catch in 1980 was over 7 times greater than the average of the run from 1970-1972, indicating that the management program had greatly increased the spawning run in Young Creek.

The catch of smolts increased from 352 in 1972 to 1849 in 1980. The estimated number of smolts actually emigrating from Young Creek was much higher than the catch due to the efficiency of the trap being only about 40-50 percent. The estimated total number of smolts in 1972 was only 500-1,000 fish as compared to 3,500-4,500 fish in 1980. Most of the smolts in 1980 were from the 1977 and 1978 year classes.

5. FLOW RECOMMENDATIONS

Cross-sectional measurements were made in a series of five riffle areas of Young Creek approximately one mile upstream from the mouth (T37N, R28W, Sec. 23). The WETP program was calibrated to field data collected at flows of 6.4, 10.8 and 70.3 cfs. The lower and upper inflection points on the wetted-perimeter discharge relationship for the composite of five cross-sections occur at flows of 3 and 7 cfs, respectively (Figure 16).
Based on an evaluation of existing fishery, recreational use, water availability and other resource information, a flow of 7 cfs is recommended for the low flow period from July 1-April 30. However, since 1973 the MDFWP has been objecting to new water permit applications on Young Creek and requesting that the provisional permit, if issued, be conditioned with the following statement:

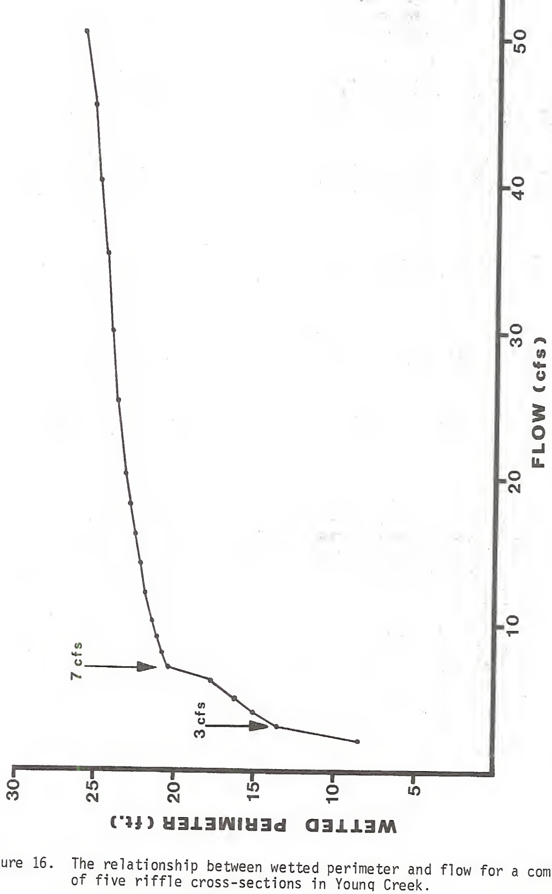

Figure 16. The relationship between wetted perimeter and flow for a composite of five riffle cross-sections in Young Creek.

"The waters appropriated pursuant to this permit shall only be appropriated when the flow of Young Creek is greater than 5 cubic feet per second."

At present, two provisional permits have been issued with this condition. This 5 cfs minimum was based on professional judgement and not derived from the field methodologies now in use. For consistency with MDFWP policy, a flow of 5 cfs is being recommended during the low flow period from July 1 through April 30.

The flow required to insure fish passage for spawning cutthroat trout is 25 cfs (Table 28). The average depth for all five riffles at this flow exceeds 0.5 ft, the approximate minimum depth required for successful passage.

Table 28. The average depth for five riffle cross-sections in Young Creek at selected flows of interest.

	Average Depth (ft)				
Flow (cfs)	Riffle #1	Riffle #2	Riffle #3	Riffle #4	Riffle #5
10	.60	.31	.55	.54	.31
20	.76	.51	.73	.85	.46
25	.82	.57	.79	.95	.51
30	.87	.62	.84	1.02	.54

The monthly flow recommendations for the low and high flow periods are compared to the mean monthly flows of record, as derived from USGS flow records for the gage near the mouth of Young Creek, in Table 29. The mean flows provide a measure of water availability during a normal or typical water year. Table 29 shows that the recommendations are less than the mean flows for all months.

The instream flow recommendations amount to 6,035 acre-feet of water per year, which is approximately 47 percent of the annual volume of water that is normally available at the USGS gaging site near the mouth of Young Creek.

Due to the lack of long term flow data, recommendations based on the dominant discharge/channel morphology concept cannot be derived for Young Creek.

Table 29. Comparison of the instream flow recommendations for Young Creek to the mean monthly flows of record.

	Flow Recommendations		Mean Flows of Record 1/	
Time Period	cfs	Acre-ft	cfs	Acre-ft
January	5.0	307	11.2	688
February	5.0	278	8.4	466
March	5.0	307	8.3	510
April	5.0	297	16.7	993
May	25.0	1,537	52.6	3,233
June	25.0	1,487	56.0	3,331
July	5.0	307	18.4	1,131
August	5.0	307	10.5	645
September	5.0	297	7.8	464
October	5.0	307	7.7	473
November	5.0	297	8.0	476
December	5.0	307	8.6	529
		6,035		12,939 2/

1/ Based on three years of partial record (March 1973-November 1975) for the USGS gage near the mouth of Young Creek (near Rexford, MT).

2/ Approximate volume of water normally available on an annual basis.

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APPENDIX A

STREAM HABITAT SURVEYS REFERENCE FORM

MEASUREMENT OF STREAM WIDTH AND DEPTH

1. Measure stream width to nearest foot. When a transect bisects separated channels, list each channel separately from left to right looking downstream, in alphabetical order, i.e., T1a, T1b, T1c, etc.

2. Measure depth at 1/4, 1/2, and 3/4 width to nearest inch. Sum of measurements + 4 = average depth.

POOL QUALITY

Size (Measurements refer to the longest axis of the intersected pool.)
3 - Pool larger or wider than average width of stream.
2 - Pool as wide or long as average stream width.
1 - Pool much shorter and narrower than average stream width.

Depth Ratings
3 - Over 3 feet
2 - 2-3 feet
1 - Under 2 feet

Total Ratings	Pool Class
8-9	1
7	2
*5-6	3
4-5	4
3	5

Cover Ratings
3 - Abundant cover
2 - Partial cover
1 - Exposed

Overall Aquatic Food Rating
3 - Greater than 25 organisms/sq. ft.
2 - 5 - 25 organisms/sq.ft.
1 - Less than 5 organisms/sq. ft.

*Sum of 5 must include 2 for depth and 2 for cover.

BANK COVER MEASUREMENTS (50 feet above and below transect)

2.0 - Medium to heavy cover of trees and/or tall shrubs
1.5 - Scattered trees and/or tall shrubs
1.0 - Medium to heavy grass forbs and/or low shrubs
0.5 - Scattered grass, forbs and/or small shrubs

(Vegetation must be within 1/2 its height of water's edge to qualify as streambank cover.)

AQUATIC VEGETATION

A - Abundant
C - Common
L - Little
N - None

FISHERMAN ACCESS

Remote - No trail
Low-Standard trail - Game or nonmaintained trail.
Improved trail - maintained
Low-standard roads - without drainage
Improved roads - with drainage

MEASUREMENT OF WATER TURBIDITY

3 - Clear)
2 - Milky) Account for source
1 - Muddy)

TICKLER LIST FOR REMARKS

1. Dams and barriers
2. Pollution information
3. Channel changes (manmade)
4. Erosion potential
5. Fish (number--size--species)
6. Creel information and fishing pressure
7. Number fish planting access sites
8. Spring sources
9. Water diversions
10. Beaver activity
11. Spawning gravel availability
12. Camera point information
13. Channel debris
14. Loss of streamflow